University of Illinois at Urbana-Champaign
College of Agriculture
Cooperative Extension Service
69 Mumford Hall
1301 West Gregory Drive
Urbana, Illinois 61801

Helping You
Put Knowledge to Work

Illinois
Cooperative
Extension
Service

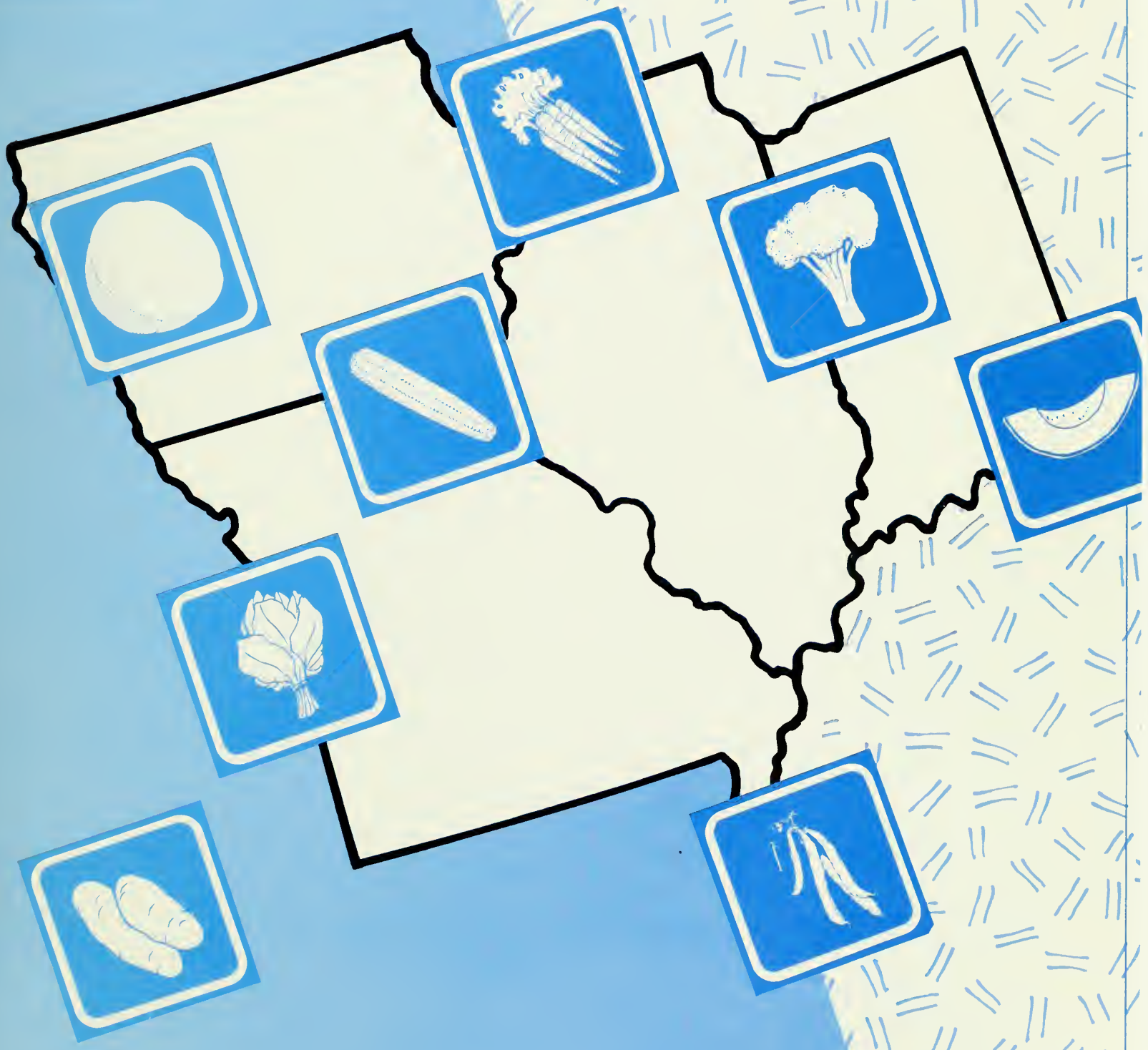
University of Illinois
at Urbana-Champaign
College of Agriculture

C1323

Midwest Vegetable Production Guide

for Commercial Growers

1993



University of Illinois Cooperative Extension Service

Illinois Poison Information Centers

St. John's Hospital
800 e. Carpenter
Springfield, IL 62706
(800) 252-2022
(Central & Southern Illinois)

Swedish American Hospital
1400 Charles St.
Rockford, IL 61104
(800) 543-2022
(Northern Illinois)

Rush-Presbyterian-St. Luke's Hospital
1653 W. Congress Parkway
Chicago, IL 60612
(312)942-5969
Outside of 312 calling area: (800)942-5969
(Chicago and Northeast Illinois)

ABBREVIATIONS FOR PESTICIDES

PHI	Pre-Harvest Interval, the minimum allowable time in days between the latest pesticide application and crop harvest
AI	Active Ingredient
COC	Crop Oil Concentrate
D	dust formulation
DF, DG	dry flowable or water dispersible granule formulation
E, EC	emulsifiable concentrate
F	flowable formulation
G	granular formulation
L, LC	liquid concentrate formulation
W, WP	wettable powder formulation

Midwest Vegetable Production Guide for Commercial Growers
1993

Editors

Purdue University: Rick Foster, Entomology (Lead Author); Richard Latin, Botany and Plant Pathology; James Simon, Steve Weller, Horticulture.

University of Illinois: Rick Weinzierl, Entomology; Darin Eastburn, Plant Pathology; John Masiunas, Horticulture.

Iowa State University: Henry Taber, Horticulture.

University of Missouri: Bruce Barrett, Entomology.

Contributors

Purdue University: Gerald E. Brust, Rick Foster, Entomology; Ralph Green, Richard Latin, Botany and Plant Pathology; Dennis Scott, James Simon, Ed Tigchelaar, Steve Weller, Horticulture.

University of Illinois: Rick Weinzierl, Entomology; Darin Eastburn, Plant Pathology; John Masiunas, Horticulture.

Iowa State University: Mark Gleason, Plant Pathology; Harlene Hatterman-Valent, Weed Science; Vince Lawson, Henry Taber, Horticulture; Donald Lewis, Entomology.

University of Missouri: Bruce Barrett, Clyde Sorenson, Entomology; Einer Palm, Hal Shafer, Plant Pathology; Ray Nabors, Area Extension Specialist.

Lincoln University: Dyremple Marsh, David Sasseville, Horticulture.

Contents

Soil Sampling and Analysis

Maintaining mineral soil at a soil pH 6.0 to 6.8 and organic soil at a soil pH 5.5 to 5.8 is recommended for most vegetable crops. Soil pH should be adjusted only on the basis of a soil test, which should be conducted routinely. If your soil has little natural buffering capacity, low clay content and low cation exchange capacity (CEC), then annual soil tests are recommended. Such sandy soils include those found along the Wabash, Illinois, Kankakee, and Mississippi rivers.

Low pH (or acid) soils can be a significant problem in most vegetable producing regions. Vegetables grown under acid soil conditions lack vigor and yield poorly. Under severe conditions, visible injury on the foliage can occur as a result of magnesium deficiency and/or manganese toxicity. The problem can be easily prevented and corrected for the next crop by a proper lime application based on soil analysis. Magnesium deficiency in low pH soils can be corrected by an application of dolomitic limestone. In low magnesium, high pH soils, magnesium can be applied as a soluble Mg salt. Be sure to inquire about the magnesium content in the limestone.

Soil samples for testing should be representative of the field, as large variations in soil pH can occur in a given field. Instructions for taking soil samples are available at your county Extension agent's office.

Soil samples should be taken at the same time of the year, preferably fall or early spring. Soil pH will vary seasonally, making comparisons between winter and summer samples difficult. Samples can be analyzed for pH, lime index, available Bray P1 phosphorus, exchangeable potassium, calcium, magnesium, CEC, color, and texture. The lime index determines the tons/acre of lime required for the field. The lime recommendation should be broadcast and worked into the entire plowlayer. In addition to the routine water pH test, soils that are susceptible to large variations in soil pH should be tested for salt pH. The pH (salt) provides a more accurate estimate of the true acidity in these soil types by simulating the effects of fertilizer salts on soil pH.

Soil samples should be sent to a commercial soil testing laboratory. A testing lab's fertilizer recommendations for the vegetable grown in a particular field will be more precise than the fertilizer recommendations given in this publication. Because soil labs use different analytical methods, different results and fertilizer recommendations may occur. Nitrogen recommendations are on the basis of past cropping history and soil characteristics.

Use of Plastic Mulch

Black plastic mulch laid before planting aids in weed control, reduces root pruning, and gives profitable increases in early yields. While black plastic is more effective for melon production in Illinois and Indiana, clear plastic is more effective than black in northern Iowa. Despite the increased weed control problem with clear plastic, it still may be advantageous to use it for very early production. The new wavelength sensitive mulches are superior to black plastic for earliness, but not as effective as clear and their cost is currently restrictive. Because leaching is retarded, less fertilizer is lost, and nitrogen sidedressing are often unnecessary with the plastic mulch. If nitrogen needs to be added, it can be applied later through the irrigation system.

Try to lay the plastic as early in the season as possible, such as from mid to late April. It should be laid as soon as the ground can be worked after a heavy rain. Plastic mulch should be laid over moist soil. If the plastic is laid over dry soil, it will actually delay subsequent transplant growth. It is better that the plastic be laid at midday so that it can be stretched tight. Do not overstretch because cool nights may actually cause the plastic to tear.

The seedbed should be as fine as possible so you can get a good covering; rototilling is preferred. The plastic is laid by burying about 2 inches of each edge.

A disadvantage of plastic mulch is disposal at the end of the season. Many landfills do not accept plastic mulches. Photodegradable plastic mulches have been developed, but their season-long persistence has been a problem and they degrade into small pieces of plastic that contaminate the environment. Biodegradable plastic mulches are not yet widely available.

Irrigation and Water Management

Vegetables require an adequate supply of moisture throughout their entire growth. While the frequency and amount of water may vary upon the individual vegetable crop, the age of the crop, current soil moisture, and type of soil and weather conditions, generally 1 to 1.5 acre inches of water are required each week.

Effective Rooting Depth of Selected Vegetables

Shallow (6-12")	Moderate (18-24")	Deep (> 36")
Beet	Brussels sprouts	Asparagus
Broccoli	Cabbage	Lima Bean
Carrot	Cucumber	Pumpkin
Cauliflower	Eggplant	Squash, winter
Celery	Muskmelon	Sweet Potato
Greens & Herbs	Pea	Watermelon
Onion	Pepper	
Radish	Potato	
Spinach	Snap Bean	
	Squash, summer	
	Sweet Corn	
	Tomato	

Irrigation is important to ensure that crops germinate and emerge properly, establish good uniform stands and grow vigorously. Inadequate moisture at the beginning of a crop's growth can result in delayed and uneven emergence, poor stands and lowered yields. Monitor the amount of rainfall and base irrigation scheduling on the water use of the crop and the soil moisture. Most vegetables grow best at 50% - 80% soil moisture. When irrigating, bring the soil's moisture content to field capacity within the effective rooting zone of the individual vegetable. **Do not wait** until crops show signs of wilting or poor growth to irrigate. While nitrogen may be applied through trickle irrigation (fertigation), it is still recommended that 50 % of total N be applied in a preplant, broadcast form.

If plastic mulch is being used, be sure that the soil is moist prior to laying the mulch. Transplants put into a dry soil under a mulch often do poorly because of the increased difficulty in uniformly 'rewetting' the dry soil.

Shortages of adequate water during specific developmental stages can seriously reduce vegetable quality and cause large yield losses. A shortage of water during these developmental stages may cause poor head or root formation in cole crops; incomplete pollination, fertilization, and seed development in corn or beans; can occur in root crops and tip burn in salad greens. Moisture stress in sweet corn can result in fewer ears, uneven tipfill and smaller ears. Water stress also may affect the plant's resistance to pests. The most critical period of water availability for vegetables is listed below*. Crops should receive adequate water during these stages and throughout the entire growing season. Water shortages during these critical periods can result in yield reductions as high as 60%, depending on the crop. Keep in mind however, that water shortages even during non-critical stages of plant development can still result in 10-20% yield reduction.

Crop*	Most Critical Period
1. broccoli, cabbage cauliflower, lettuce	head development
2. carrot, radish, beet, turnip	root enlargement
3. sweet corn	tasseling and ear development
4. cucumber, eggplant, pepper, melon, tomato	flowering, fruit set and maturation
5. bean, pea	flowering, fruit set and development
6. onion	bulb development

*For transplants, transplanting and stand establishment represent a most critical period for adequate water.

Approximate Time from Pollination to Market Maturity Under Warm Growing Conditions

Vegetable	Days to Market Maturity
Bean	7-10
Corn, market	18-23*
Corn, processing	21-27*
Cucumber, pickling (3/4-1 1/8 inch in diameter)	4-5
Cucumber, slicing	15-18
Eggplant (2/3 maximum size)	25-40
Muskmelon	40-50
Okra	4-6
Pepper, green stage (about maximum size)	45-55
Pepper, red stage	60-70
Pumpkin, Jack-o-lantern	90-120
Pumpkin, Baking	65-75
Squash, summer, Zucchini	3-4**
Squash, winter, Butternut	60-70
Squash, winter, Hubbard	80-90
Squash, winter, Table Queen or Acorn	55-60
Tomato, mature green stage	35-45
Tomato, red ripe stage	45-60
Watermelon	40-50

* From 50% silking

** For a weight of 0.25-0.5 lb.

Yields of Vegetable Crops

Crop	Expected Yields in Tons per Acre		
	Average	Good	Excellent
Asparagus	1	1-2	2
Bean, snap	2	4	5
Cabbage	13	15	20
Corn, sweet	3	8	10
Cucumber, slicing	4	12	15
Cucumber, pickling, hand harvest	7	10	12
Muskmelon	8	12	16
Onion	15	20	25
Pepper, green	5	10	13
Potato (fall)	10	15	20
Tomato, fresh market	6	13	15
Tomato, processing	20	25	35
Watermelon	8	12	20

Postharvest Handling and Storage Life of Fresh Vegetables

Careful attention should be given to the postharvest handling and storage of fresh market vegetables. Lack of adequate refrigeration and cooling will result in a shortened shelf-life and lower quality of the fresh vegetable. The following list of recommended storage condition information has been modified from Lorenz & Maynard's *Knott's Handbook for Vegetable Growers.*

	Storage Conditions			
Vegetable	Highest Freezing Temperature (°F)	Temperature (°F)	Relative Humidity (%)	Relative Storage Life
Broccoli	31	32	90-95	10-14 days
Cabbage, late	30	32	90-95	3-4 months
Cauliflower	31	32	90-95	2-4 weeks
Corn	31	32	90-95	4-8 days
Cucumber	31	45-50	90-95	10-14 days
Muskmelon	30	36-40	85-90	5-10 days
Watermelon	31	40-50	80-85	2-3 weeks
Pepper, green	31	45-50	90-95	2-3 weeks
Pepper, ripe	31	40-45	90-95	1 week
Potato, early	31	Note [1]	90	Note [1]
Potato, late	31	Note [2]	90	Note [2]
Pumpkin	30	50-55	70-75	2-3 months
Squash, winter	30	50-55	50-75	Note [3]
Tomato, mature-green	31	55-70	85-90	1-3 weeks
Tomato, firm-ripe	31	45-50	85-90	4-7 days

[1] Most summer-harvested potatoes are not stored. However, they can be held 4-5 months at 40°F if cured 4 or more days at 60-70°F before storage. They can be stored 2-3 months at 50°F without curing. Potatoes for chips should be held at 70°F or conditioned for best chip quality.

[2] Fall-harvested potatoes should be cured at 45-60°F and high relative humidity for 10-14 days. Storage temperatures for seed or table stock should be lowered gradually to 38-40°F. Potatoes intended for processing should be stored at 50-55°F. Those stored at lower temperatures or with a high reducing sugar content should be conditioned at 70°F for 1-4 weeks or until trial cooking tests are satisfactory.

[3] Winter-squash varieties differ in storage life. Table Queen squash can be stored for 35-55 days; Butternut, 60-90 days; Hubbard, 180 days.

Care should be taken not to keep the temperature too low. Cucumber, eggplant, lettuce, sweet pepper, potato, snap bean, squash and tomato are among the most susceptible vegetables to chilling or freezing injury. Some of the typical symptoms of cold injury which can make the vegetables unmarketable include pitting, water-soaked spots, browning and surface decay .

Farm Labor Law Information

To obtain information about the Immigration and Reform Act and current related farm/labor laws which specify employer responsibilities and seasonal agricultural worker status, contact:

In Indiana:
Immigration and Naturalization Service (INS). John Klemme, Officer in Charge, 950 N. Meridian Street, Indianapolis, IN 46204. INS Toll-free Hotline: (317)226-6009.

Migrant Farmworkers Project. Nancy Hale, Director, 151 N. Delaware Street, Suite 1800, Indianapolis, IN 46204. Toll-free: (800) 869-3505 or (317) 631-4910 ext. 236.

In Illinois:
Travel Control Section, Immigration and Naturalization Service, 10 W. Jackson, Chicago, IL 60604, (312) 353-7334.

(Migrant Farm Workers and Farm Labor) Department of Labor, 310 S. Michigan Ave., Chicago, IL 60604, (312) 793-2804.

In Missouri:
Information unavailable.

In Iowa:
Iowa Dept. of Employment Services, Attn: George Selser, Bureau of Field Operations, 1000 East Grand Ave., Des Moines, IA 50319-0209 (515) 281-5854

Precautions with Pesticides

Most of the pesticides you use are designed to poison or otherwise manage pests. Unfortunately, many management pesticide products may poison people, pets, livestock, wildlife, ornamental plants and other non-target organisms. Pesticide applicators and their families have the potential to be exposed to a greater degree than non-agricultural employees. Therefore, it is important to do everything possible to keep all exposures to an absolute minimum.

You must protect your family members and field workers and other people from pesticide injuries. Most pesticide accidents result from careless practices or lack of knowledge about safe handling of pesticides. The time you spend to learn about the safe use of pesticides is an investment in the health and safety of yourself, your family, and others.

The Environmental Protection Agency has certain restrictions on the use of pesticide chemicals. These restrictions apply to the use of chemicals applied to control insects, mites, plant diseases, weeds, nematodes and other pests. Such restrictions may prohibit the use of a chemical or allow residue tolerances on harvested vegetables. A grower must know what chemical to use on each vegetable; how to apply; the post-treatment re-entry interval, if any; when to use the chemicals with respect to farmworker and/or picker safety; and the environment and the harvest of each vegetable crop. The grower must follow all label instructions regarding harvest restrictions (1) to assure the consumer that the food is free of dangerous residues and (2) to comply with the law to prevent seizure of his crop.

- Only mix the amount of a pesticide that you can use in one day.
- If you do have leftover spray mix, the best way to dispose of it is by applying it to a labeled crop in a legal manner.
- Never dispose of surplus pesticides in a way that will result in the contamination of ground or surface waters.
- Rinse all empty containers three times before disposal.
- Pour the rinse water into the spray tank. Puncture or break triple-rinsed containers to facilitate drainage and to prevent reuse for any other purpose.
- Then dispose of the container according to label directions.

RULES FOR USING PESTICIDES WITH "DANGER" SIGNAL WORD

Formulations of Monitor, Lannate, Phosdrin, Thimet, DiSyston, Furadan, Guthion, and Systox are highly poisonous. They should not be applied unless applicators strictly follow all precautions listed on the pesticide label. Some of those listed are the following:

- When handling or applying these materials, always wear the proper respiratory equipment as listed on the label.
- Always wear protective clothing to cover as much of the body as possible.
- Never handle pesticides with your bare hands. Wear rubber gloves, not leather or cloth gloves.
- Avoid breathing these pesticides when opening the containers or mixing into the spray tanks.
- Always wash hands, arms, and face immediately after handling pesticides and before eating or smoking. Never smoke while handling or applying pesticides.
- During the spraying operation, work in a manner to reduce all possible hazards of coming into direct contact with spray drift. In fact, if wind conditions make it difficult to stay out of the drift, don't spray. If you must, wear all protective clothing as listed on the pesticide label.
- After each day's work, take a thorough shower or bath, and change clothes. Wash spray clothes separately from the family wash, and after washing clothes, run another complete hot water and detergent wash cycle through the washer before washing family clothes.
- Wear clean overalls, underwear, socks and cap each day you spray.
- Always keep pesticides in their original labeled containers and store in a safe place. Store and dispose of containers according to information on the pesticide label.

SYMPTOMS OF PESTICIDE POISONING

Poisoning symptoms include headache, blurred vision, pinpoint pupils, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Symptoms can begin almost immediately after exposure or may be delayed for several hours. Call a physician any time you are concerned about illness due to contact with a pesticide.

If you experience any of these symptoms during exposure to pesticides, stop spraying or dusting immediately, and have someone take you, or go yourself, to a doctor. Do not resume spraying or dusting until you have consulted a doctor and the tests show it is safe to continue. When going to the doctor, take along the pesticide label or a sample label of the pesticide you have been using, material safety data sheet, and if possible, the phone number of the manufacturer. This information is extremely critical for the doctor to make a proper diagnosis.

EMERGENCY TREATMENTS

Medical antidotes should be prescribed or given only by a qualified physician. First aid treatments should be given by someone having a basic knowledge of first aid as it relates to pesticide poisoning. In advance, prepare a well thought out plan of action to follow in the event of an accident with pesticides! First aid can be used initially to help a victim while medical help is on the way, or can be administered to a victim enroute to qualified help.

Call a doctor, an emergency medical service, or an Area Poison Information Center for immediate help. Know whether the label has a telephone emergency information number printed on it. **Poison Information Centers have been established in Illinois, Indiana, Iowa, Missouri, and surrounding states to provide physicians with current information on diagnosing and treating accidental poisoning cases.**

In case of accidental poisoning, first call a physician or hospital. Give them information about the poisoning, especially the name of the pesticide product. If they do not have a poison information center there, they should be able to put you in contact with the nearest one. If not, consult your local hospital and get the name, address, phone number, and director of the center nearest you. You should get this information now just to have it available should the need arise.

Use of Bees with Vegetable Crops

In most vegetable plants, seed or fruit development depends on pollination and fertilization. In most cases, this involves the transfer of pollen from the male portion of the flower to the female portion. Pollen is also used as a food source by a wide spectrum of insects. It is especially important to a number of bee species specializing in pollen collection. In the process of collecting this valuable food source, these insects provide the pollen transportation link that many plants need for reproduction. A single honey bee can carry up to five million pollen grains on its body, and a strong honey bee colony may bring in well over 50 pounds of pollen during a season.

Other factors influence the honey bee's role as the pollinating leader. Only honey bees are significantly socially developed to overwinter as a colony. This is the key element that makes it possible for man to manage honey bees. Populations of naturally occurring bee species have been declining for the last few decades. This may be due to a number of factors, including the reduction of natural habitats, parasitic mites, brood diseases, and pesticide use.

At least 90 crops grown in the United States depend to some extent upon bees as pollinators, either for seed or fruit production. The exact number of hives needed will depend on a number of factors including strength and condition of colonies, magnitude of the natural pollinator community, amount of wild flower material competing with the crop, attractiveness of the crop to bees, projected yield, and the weather. The following are guidelines for the number of hives to use when supplemental pollination is desired:

cucumber	(1 to 2 colonies per acre)	squash	(1 to 3 colonies per acre)
muskmelon	(1 to 2 colonies per acre)	watermelon	(1 colony per acre)
pumpkin	(1 to 3 colonies per acre)		

The following vegetables will set fruit without bees, but bee activity has shown to increase yields:

eggplant	lima bean	okra	pepper

Honey bees do not assist in the pollination of the following crops, but will collect pollen and nectar from them:

peas	snap bean	sweet corn	tomato

Many growers currently purchase pollination services from beekeepers for their vegetable fields. To ensure mutual satisfaction of both grower and beekeeper, a pollination contract should be signed by both. The following points should be considered in the contract: rental price, number of colonies, strength of colonies, timing of placement in the fields and removal from fields, field location, responsibility for maintenance of the colonies, access for the beekeeper to the hives, liability for stings, and protection from pesticides.

Generally, a grower should require that any hive he rents for pollination should have two deep supers (boxes); a good egg-laying queen; at least 4 to 5 frames of immature bees; 20+ pounds of surplus honey; and be disease free. Hives should only be placed in fields after the crop's flowers are available to visit by the bees. If hives are placed before there are available flowers, bees will forage in surrounding areas and may not return to pollinate the flowers of the intended field. Also, when planning where to place the hives, growers should remember that honey bees usually pollinate flowers most thoroughly within 100 yards of their colony, although if forced to, they will travel much farther. Thus, hives should be distributed in groups throughout the field rather than in a single location, with convenience to the beekeeper in mind as well as uniform pollination.

Certain pesticides and pesticide application practices pose a serious hazard for honey bees. In general, applications made at night pose the least hazard to bees, with applications made in early morning second best. The application of a single pesticide is usually less dangerous than applying combinations. Systemic insecticides are usually very safe to bees, as are granular formulations. Emulsifiable or water soluble formulations are safer than wettable powders of the same material. The list of insecticides on page 90 defines the degree of toxicity to honey bees.

For protection of the honey bees and his own liability, a grower should work closely with the beekeeper in developing a program regarding pesticide application scheduling and application.

Use of Bees with Vegetable Crops (cont.)

Highly Toxic Insecticides

Severe bee losses can be expected if the following materials are used when honey bees are present at treatment time or within a day thereafter.

Ambush, Asana, Cygon, Cythion, Diazinon, Dibrom, Dimethoate, Furadan, Guthion, Imidan, Lindane, Lorsban, Malathion, Monitor, Orthene, Penncap-M, Phosdrin, Pounce, Sevin, Supracide

Moderately Toxic Insecticides

These can be used in the vicinity of honey bees if the dosage, timing, and method of application are correct. However, they should not be applied directly on honey bees in the field or at the hives.

Di-Syston, Lannate, Metasystox R, Thiodan, Thimet, Vydate

Relatively Non-Toxic Insecticides and Acaricides

This group of materials can be used around honey bees with a minimum of injury.

Bacillus thuringiensis **(MVP, Dipel, Javelin, Thuricide, Biobit, M-One, etc.) Dylox, Kelthane, Methoxychlor, Omite, Proxol, Pyrethrum, Rotenone**

Re-entry Standards/Worker Protection

The Environmental Protection Agency has announced new Worker Protection Standards that drastically change re-entry standards for fields treated with pesticides. Under the old standards, many pesticides required workers to wait until dusts had settled or sprays had dried. Other, more toxic materials, required that workers wait from 1 to 14 days before re-entering a treated field. The new restrictive-entry intervals are:

- 48 hours for toxicity Category I pesticides (signal words "Danger/Poison" on the label). If organophosphate pesticides are applied in low rainfall areas (less than 25 inches per year), the re-entry interval becomes 72 hours.
- 24 hours for Category II (signal word "Warning" on the label).
- 12 hours for all other pesticides.

The new pesticide labels will begin to appear after April 15, 1993. Labels will include specific instructions regarding personal protective equipment, restrictive-entry intervals, and instructions for oral and written warnings for workers.

FUNGICIDE/INSECTICIDE COMPATIBILITY CHART

1. Materials compatible
2. Not compatible
3. Questionable, compatibility not clear, or generally not mixed together

Ambush																		
1	Bayleton																	
1	1	Benlate, Topsin M																
3	1	1	Bravo															
1	3	2	1	Copper (fixed)														
1	1	1	1	1	Cygon													
1	1	1	3	1	1	Diazinon												
3	1	1	1	3	1	3	Dyrene											
1	1	1	3	1	1	3	1	Guthion										
3	1	1	1	3	1	3	3	1	Karathane									
3	1	1	1	1	1	1	2	1	3	Lannate								
1	1	1	1	3	1	1	3	1	1	1	Lorsban							
1	1	1	1	1	1	1	1	1	1	1	1	Mancozeb, Maneb						
1	1	1	1	3	1	1	3	1	1	1	1	1	Pounce					
1	1	1	1	3	1	1	3	1	1	1	1	1	1	Penncap M				
3	3	1	1	3	3	1	3	1	3	3	3	1	3	3	Ridomil			
1	1	1	1	3	1	1	3	1	1	1	3	1	1	1	3	Rovral		
1	1	1	1	2	1	1	1	1	3	1	1	1	1	1	3	1	Sevin	
1	1	1	3	1*	1	1	1	1	1	1	1	1	1	1	3	1	1	Thiodan
3	1	1	1	3	1	1	3	1	1	1	1	1	3	1	1	1	1	1	Vydate

* WP formulation of Thiodan only

Insect Management Strategies

Effective management of insects and mites involves at least six steps.

1. Proper identification of key pest insects and mites and beneficial organisms.
2. Selection and use of preventive pest management practices.
3. Monitoring the current status of insect and mite populations.
4. Determining the potential for economic loss from the pest.
5. Proper selection of a pest control option.
6. Evaluation of the effectiveness of control options previously used.

PROPER IDENTIFICATION

Proper identification of pests is the foundation on which a good insect management program is built. If the pest is not properly identified, the chances of selecting the correct control strategies are greatly diminished. Many insects and mites can be correctly identified simply because they are encountered so often. However, it never hurts to back up your knowledge base with some reference materials. A number of extension bulletins are available from your county extension agent that will help growers properly identify insect pests. There are also a number of good books available with color photographs of many of the common insect pests. Most entomologists don't like to admit it, but we often identify unfamiliar insects by comparing them to pictures in a book.

As will be discussed in the next section, beneficial organisms can be important components of an insect management program. Being able to distinguish the good guys from the bad guys may help you to avoid unnecessary and possibly disruptive pesticide sprays. Some common beneficial organisms that all growers should be able to identify include lady beetle larvae and adults, lacewing larvae and adults, and syrphid fly larvae.

In addition to proper identification, it is helpful to know as much as possible about the biology of the insect. All growers should know the difference between insects with incomplete metamorphosis and those with complete metamorphosis. Insects with incomplete metamorphosis have juvenile stages, called nymphs, that resemble the adult stage except that they are smaller and don't have wings. The feeding behavior is usually the same for nymphs and adults. An example of an insect with incomplete metamorphosis is the squash bug. Insects with complete metamorphosis have a larval stage that is completely different in appearance from the adult. They also have an intermediate stage, known as a pupa, between the larval and adult stages. Larvae never have wings and are not capable of reproducing. Larvae go through a series of molts (shedding their skin) in order to grow. Larvae and adults frequently, although not always, feed differently. Adult insects never grow, so little beetles don't grow up to be big beetles. Caterpillars are examples of larvae, and the adult stage of a caterpillar is a moth or butterfly. For important insect and mite pests it is helpful to know the overwintering stage, the length of the life cycle, and the number of generations per year that can be expected. Again, most of this information can be found in extension bulletins.

PREVENTIVE INSECT MANAGEMENT PRACTICES

There are a number of practices that can be employed to reduce insect numbers before you actually see the insects in the field. Often these decisions must be made based on past experience with the insect, rather than current knowledge of the severity of the infestation. Many of these practices are good management practices for weeds and diseases as well, so they can easily be incorporated into an overall insect management program.

Resistant Varieties: There are not many vegetable varieties that have been bred for resistance to insects. However, there are some varieties of cabbage that are resistant to onion thrips. Selection of sweet corn varieties that have husks that completely cover the ear tip and fit tightly around the ear can reduce the amount of corn earworm damage. Short season varieties of potatoes should be grown when possible to give Colorado potato beetles less time to feed and reproduce. This is not resistance, but it is a method which growers can use to reduce insect damage by varietal selection.

Crop Rotation: Rotating crops can reduce the severity of a number of pest problems. Corn rootworms are not a problem in corn that is planted on land that did not have corn growing there last year. Rotating potato fields can greatly increase the amount of time it takes Colorado potato beetles to colonize a field, thereby reducing the time the beetles have to increase to damaging levels. Don't plant crops that are susceptible to wireworm or white grub damage in fields that were previously in sod or heavily infested with grassy weeds.

In addition, it is a good idea not to plant cabbage or onions next to small grain fields, because onion thrips build up to very high levels in small grains and may move into cabbage or onions when the small grains dry down or are harvested.

Crop Refuse Destruction: Destroying the plant residue after harvest can reduce the damage experienced the next year from a number of insects. Destroying squash and pumpkin vines after completion of harvest can greatly reduce the overwintering population of squash bugs and squash vine borers. Early vine killing in potatoes will reduce the potato beetle populations for the following year.

Tillage: Fields that receive reduced amounts of tillage or have some sort of grass windbreaks are often more susceptible to damage from such insects as cutworms and armyworms. These cultural practices may have other advantages that outweigh the potential insect problems, but growers should be aware of the potential for increased insect activity.

Time of Planting: Because insects tend to become active at specific times each year, varying the time of planting can sometimes help to avoid serious insect problems. Corn earworms and fall armyworms are usually a much more serious problem on late planted sweet corn. If the option is available, planting sweet corn so that it has no green silks before large numbers of earworm moths are flying can reduce earworm problems. Root maggots are usually more serious during cool, wet weather. Waiting until soil temperatures are adequate for rapid plant growth will help reduce maggot problems.

Biological Control: One aspect of biological control that can effectively reduce pest populations and damage is conservation of natural enemies. This can be accomplished in several ways, but the most important is by reducing the number of insecticide applications. Each time a spray is applied, more predators and parasites are killed. When deciding to use an insecticide, you should consider the impact that application will have on beneficial insects. *Bacillus thuringiensis* products do not harm beneficial insects.

Monitoring

Vegetable growers must make decisions concerning management of insect and mite pests on an almost daily basis during the growing season. To make the best management decision, it is often useful to have information regarding the current status of a pest's population. This can be accomplished through some sort of sampling or monitoring program. There are several methods that can be used to monitor insect populations.

Pheromone traps can be used to determine when moths are flying. This information can be used in several ways. First, catching moths in the trap can alert the grower to begin looking for the pest in the field. This can save time because the grower won't be looking for the pest before it is present. Second, pheromone trap catches can be used to time insecticide applications. Third, for some pests such as corn earworms, the need to spray can be determined from the number of moths caught in the trap. Pheromones are available for many of the caterpillar pests of vegetables.

The most common method for monitoring insects is by scouting the field. Scouting can be formal, such as counting insects on a given number of plants throughout the field, or it can be informal, with the grower walking through the field and looks for insects on the plants. Formal scouting may be the more accurate, but the most important thing is for growers to regularly walk their fields looking for insects or insect damage. Some pests, such as mites, may require the use of a hand lens to see. Others may require the use of equipment such as a sweep net or a beat cloth. Most can be monitored just by close inspection of the plants. Regular (weekly) monitoring of fields will allow growers to make informed management decisions.

Determining the Potential for Economic Loss

Unfortunately, we do not have economic thresholds for many vegetable insect pests. As a result, most growers must rely largely on their past experiences to determine the potential for loss. Extension bulletins are also useful sources of information regarding potential losses from insects. Growers should remember that some crops, such as snap beans and potatoes, can suffer a great deal of defoliation before there is any effect on yield. Sometimes plants with considerable amounts of insect damage will yield as well as plants that have no insect feeding. If the pest is one that feeds on the marketable portion of the plant, then less damage can be tolerated.

Proper Selection of a Pest Control Option

In vegetable crops, the selection of a control option during the growing season usually means doing nothing or selecting a pesticide. Although we always encourage growers to read and follow label directions, the one area where the label is not necessarily the best source of information is concerning which insects the insecticide will control. The insecticides recommended in this book for control of various pests are listed because they are legal to use and because they have been found to be effective by the authors. Consider the cost of the insecticide, application costs, the relative effectiveness, the gain in profits that can be expected from the application, whether it will control other pests, and how it will affect predators, parasites, and pollinators. Growers should refrain from "revenge spraying," that is, spraying after the damage is already done. At that point, spraying is a waste of money and may actually increase pest damage by killing beneficial insects.

Evaluation

Growers should always evaluate the effectiveness of a pest control action. Inspecting the field a couple of days after an insecticide is applied will help the grower to determine the necessity for additional control measures in that field, as well as providing information about the effectiveness of the insecticide for future reference. Growers should pay attention to whether the insecticide killed all stages of the pests or if only small larvae or nymphs were killed. They should also notice the effects on other pests in the field and on the beneficial insects.

Insecticides & Acaricides Registered For Use On Midwest Vegetables in 1993*

	Ambush, Pounce	Ammo, Cymbush	Asana	Bacillus thuringiensis	Counter	Cygon, DeFend	Diazinon	Dibrom	Di-ayston	Dyfonate	Dylox, Proxol	Furadan	Guthion	Lannate	Larvin	Lorsban	Malathion, Cythion	Metasystox-R	Methoxychlor	Methyl parathion	Mocap	Monitor	Orthene	Phosdrin	Phosphamidon	Pyrethrum	Rotenone	Sevin	Thimet	Thiodan	Vydate
Asparagus	X			X						X				X		X	X		X							X	X	X			
Beet				X			X			X	X			X			X		X					X		X		X			
Broccoli	X		X	X		X	X	X	X	X				X	X	X	X	X	X			X		X		X	X	X		X	
Brussels Sprouts	X			X			X	X	X	X				X		X	X	X	X			X	X	X		X	X	X		X	
Cabbage	X		X	X		X	X	X	X	X				X	X	X	X	X	X	X	X	X		X		X	X	X		X	
Cantaloupe	X		X	X		X	X	X				X	X	X			X	X	X					X		X		X		X	X
Carrot			X	X			X							X			X		X					X		X		X		X	X
Cauliflower	X		X	X			X	X	X	X				X	X	X	X	X	X			X	X	X		X	X	X		X	
Celery	X			X			X	X						X	X		X						X	X		X	X	X		X	
Chinese Cabbage	X		X	X					X					X		X										X		X			
Collard			X	X		X	X	X						X		X	X		X					X		X	X	X		X	
Cucumber	X		X	X			X	X				X	X	X			X	X	X		X			X		X		X		X	X
Eggplant	X		X	X				X					X	X			X	X	X					X		X	X	X		X	X
Endive	X			X		X	X							X	X		X									X		X			
Green Onion				X			X						X	X			X			X				X		X					
Head Lettuce	X	X		X		X	X		X					X	X		X	X	X				X	X		X	X	X		X	
Kale				X		X	X	X						X		X	X		X					X		X	X	X		X	
Kidney Bean			X	X		X		X	X	X				X			X		X	X			X	X		X		X	X	X	
Leaf Lettuce	X			X		X	X		X					X	X		X		X					X		X	X	X		X	
Lima Bean				X		X	X	X	X	X				X			X	X	X	X	X		X	X		X		X	X		
Mint				X						X				X		X	X	X					X								
Mustard				X		X	X							X			X							X		X	X	X		X	
Onion Bulb	X			X			X			X			X	X		X	X			X						X					
Parsley	X			X			X							X	X		X									X		X			
Parsnip				X			X										X									X		X			
Peas			X	X		X	X	X	X					X			X		X	X				X		X		X		X	
Pepper	X		X	X		X	X	X		X			X	X			X	X	X				X	X		X	X	X		X	X
Potato	X		X	X		X	X		X	X		X	X	X			X		X	X	X	X			X	X	X	X	X	X	X
Pumpkin	X		X	X				X			X	X					X	X	X							X		X		X	
Radish			X	X			X			X						X	X		X							X	X	X			
Rhubarb	X			X											X											X					
Snap Bean			X	X		X	X	X	X	X				X			X	X	X	X	X		X	X		X	X	X	X	X	
Spinach	X			X		X	X	X						X	X		X		X					X		X	X	X		X	
Summer Squash	X		X	X			X	X				X		X			X	X	X					X		X		X		X	X
Sweet Corn	X		X	X	X		X			X	X	X		X		X	X	X	X	X	X			X		X		X	X	X	
Sweet Potato				X			X									X	X		X		X					X		X		X	X
Tomato			X	X		X	X	X	X	X	X		X	X			X		X	X				X		X	X	X		X	X
Turnip				X		X	X	X						X		X	X	X	X					X		X	X	X			
Watermelon	X		X	X		X	X	X					X	X			X	X	X					X		X		X		X	X
Winter Squash	X		X	X			X	X				X					X	X	X							X		X		X	X

* Check label directions before applying any of these pesticides. Consult your Extension agent or the Entomology Department at your land grant institution for further information.

Common Names of Registered Insecticides and Acaricides

Common Name	Trade Name	Producer	Formulation
acephate	Orthene	Valent	75S
azinphosmethyl	Guthion	Mobay	2S, 50WP, 35WP
Bacillus thuringiensis var. *kurstaki*	Dipel	Abbott	ES, 2X WP, 4L ES, 10G
	MVP	Mycogen	A
	Javelin	Sandoz	WG
	Biobit	DuPont	F, WP
B. thuringiensis var. san diego	M-One	Mycogen	5.6%
	M-Trak	Mycogen	10%
B. thuringiensis var. tenebrionis	Trident II	Sandoz	0.64%
	Novodor	Novo Nordisk	3%
carbaryl	Sevin	Rhone Poulenc	50WP, 80S, 5%D, 5B
carbofuran	Furadan	FMC, Mobay	4F, 15G
chlorpyrifos	Lorsban	Dow	4E, 15G
cypermethrin	Ammo	FMC	2.5EC
	Cymbush	ICI	3E
diazinon	Diazinon	Ciba-Geigy	50WP, AG500, 4EC, 14G
endosulfan	Thiodan	FMC	50WP, 3EC
esfenvalerate	Asana XL	DuPont	0.66 EC
ethoprop	Mocap	Rhone Poulenc	10G, 15G, 20G, 6EC
dimethoate	Cygon	American Cyanamid	400 (4EC)
disulfoton	Di-Syston	Mobay	8EC, 15G
fonofos	Dyfonate	ICI	4EC, 20G
malathion	Cythion, Malathion	American Cyanamid	57EC
methamidophos	Monitor	Valent, Mobay	AC
methomyl	Lannate	DuPont	90WSP, 1.8WSL, 2.4WSL
methoxychlor	Marlate, Methoxychlor	Kincaid	50WP
methyl parathion	Penncap-M	Atochem	2F
mevinphos	Mevinphos	Platte	4EC
naled	Dibrom	Valent	8EC
oxamyl	Vydate	DuPont	2WSL
oxydemeton-methyl	Metasystox-R	Mobay	2SC
permethrin	Ambush	ICI	2EC, 25WP
	Pounce	FMC	3.2EC, 25WP, 1.5G
phorate	Thimet	American Cyanamid	20G
rotenone	Rotenone Soln FK-11	Fairfield	1.5 + 2.5 pip. butoxide.
	Foliafume	Penick-Bio	4.3%
	Noxfire	Penick-Bio	5%
	PB-Nox	Penick-Bio	4.3%
	Rotenone	Pratt-Miller	1D
terbufos	Counter	American Cyanamid	15G
thiodicarb	Larvin	Rhone-Poulenc	3.2
trichlorfon	Dylox	Mobay	80SP
	Proxol	Nor-Am	80SP

A= aqueous, B = bait, D = dust, E or EC = emulsifiable concentrate, ES = emulsifiable suspension, G = granules, HPC = high potency concentrate, S or SP = sprayable powder, W or WP = wettable powder, WSL = water soluble liquid, WSP = water soluble powder, WG = wettable granule.

Weed management requires a multifaceted approach, built upon an understanding of weeds and the crop. Weed management may involve nonchemical methods, chemical methods (herbicides), or a combination of the two. Their aim should be to manage the weed population so it is below a level which will cause a reduction in your economic return (economic threshold). The decision on which methods to use depends on environmental concerns, marketing opportunities, desired management intensity, labor availability, weed pressure, and the crop. In some instances, the cost of controlling weeds may be more than the economic return obtained from any yield increase. This situation occurs when a few weeds are present or the weeds germinate late in the season. In those instances, the best strategy may be to do nothing. In other situations, weed populations and other considerations may require combining herbicides with nonchemical approaches.

The first step in weed management is to identify the weeds and understand their life cycles. Consult identification guides, such as *Weeds of the North Central States* (Bulletin 772, College of Agriculture, University of Illinois at Urbana-Champaign), for assistance. Weeds can be categorized by life cycles, and management strategies developed accordingly.

Annual weeds complete their life cycles in one year and reproduce solely by seeds. Annuals can be divided into summer or winter annuals depending on when they grow. Primary tillage operations often control winter annuals before a crop is planted in the spring. The most common vegetable crop weeds (i.e. barnyard grass, giant foxtail, common purslane, redroot pigweed, and common lambsquarters) are summer annuals.

Perennial weeds live for more than two years and can reproduce by seed or vegetative structures (stolons, rhizomes, corms, bulbs, tubers, or roots). Because perennial weeds are difficult to manage in vegetable crops, it is usually better not to use a field with severe perennial weed problems.

Many nonchemical weed management methods are common sense farming practices. These practices are of increasing importance due to consumer concerns about pesticide residues, potential environmental contamination from pesticides, and unavailability of many older herbicides.

Table 1. Botanically Related Vegetables

Corn	Cucurbits	Crucifers	Legumes
Sweet corn	Winter squash	Rutabaga	Soybean
Dent corn	Summer squash	Kale	Pea
Onions	Pumpkin	Broccoli	Snap Bean
Onion	Muskmelon	Cauliflower	Lima Bean
Garlic	Watermelon	Cabbage	Dry Bean
Spinach	**Solanaceous**	Brussels sprout	
Beet	Potato	Radish	
Chard	Tomato	Horseradish	
Spinach	Pepper		

Cultural Practices

Farm practices should aim to establish a vigorous crop that competes effectively with weeds. This starts with *land selection*. A general rule is not to plant vegetables on land with a history of heavy weed infestation, especially perennial weeds. *Crop selection* can reduce the affects of weed competition. One criterion in selecting a crop should be the weed problems of the field. Plant the most competitive crops in the most weed-infested fields and the least competitive crops in the cleanest ones. Consider planting heavily infested fields as long-term set-aside acres or in nonrow crops such as alfalfa. Permanent cover should help prevent buildup of annual weeds.

Crop rotation is another practice which can reduce weed problems. The characteristics of the crop, the methods used to grow it, and the herbicides used inadvertently allow certain weeds to escape control. Rotation also effects the weed management tools at your disposal. Rotating between crops will improve crop growth and competitiveness. Related vegetables should not be grown in the same location in successive years (Table 1).

Wild proso millet is an example of a problem weed where rotation is important for management. Rotation from sweet corn to small grains, early-planted peas, or alfalfa almost completely eliminates wild proso millet since these crops are established before the soil is warm enough for wild proso millet seed germination. A rotation from sweet corn to broadleaf crops would allow use of postemergence grass herbicides to manage wild proso millet.

Once a crop is selected, use adaptive vigorous varieties resistant to diseases. Disease-infected plants cannot effectively compete with weeds. Varieties suited for cultivation in Illinois and Indiana are listed in each crop section of this production guide.

Table 2. Classification of Vegetable Crops According to Their Adaptive Field Temperatures

Cool-season		Warm-season	
Hardy*	**Semi-Hardy**	**Tender**	**Very Tender**
Asparagus	Carrot	Snap bean	Cucumber
Broccoli	Cauliflower	Sweet corn	Eggplant
Cabbage	Chinese cabbage	Tomato	Lima Bean
Horseradish	Lettuce		Muskmelon
Onion	Potato		Okra
Pea			Pumpkin
Spinach			Squash
			Watermelon

* Hardy crops are most tolerant of cool temperatures and frost, while very tender crops are most susceptible to frost and cool temperatures.

Narrower row spacings and proper plant densities assure crop closure. A closed canopy shades out later emerging weeds and prevents germination of weed seeds requiring light. Weeds seldom are a problem once canopy closure occurs. Proper row spacing and plant density also allow row cultivation.

Another cultural method to improve crop competitiveness is to use the *correct planting time*. Crops can be divided into warm- or cool-season plants, depending on the optimum temperature for their growth. Planting date affects the time to emergence and early seedling vigor of the crop, which are important in determining crop competitiveness. Cool-season crops germinate at cooler soil temperatures and thus compete better against early emerging weeds than warm-season crops. Table 2 lists crops according to their adaptation to field temperatures. Time plantings so that temperatures are favorable for crop growth. *Adequate fertilization and appropriate insect and disease management* are important in assuring a competitive crop. Adequate fertility assures rapid, uniform germination and good crop growth, which enhance the crop's competitive ability. Disease management information and insect management information are contained in this guide. While poor insect and disease control reduce a crop's competitiveness, inadequate weed control can also cause insect and disease problems.

Mulching can be useful in managing weeds. Mulches can be classified as either natural (straw, leaves, paper, and compost) or synthetic (plastics). Because natural mulches are difficult to apply over large areas, they are best for small specialized areas.

Natural mulches should be spread evenly at least 1 to 1.5 inches thick over the soil to prevent light penetration. Natural mulch materials must be free of weed seeds and other pest organisms and be heavy enough so they will not be easily displaced by wind or water. A major advantage of natural mulches is that they add organic matter to the soil and do not need to be disposed of at the end of the season.

Synthetic mulches are easy to apply, control weeds within the row, conserve moisture, and increase soil temperature. Black or clear plastic mulches are the most common and are effective in improving early-season growth of warm-season crops such as tomato, muskmelon, watermelon, or pepper. Fast early-season growth of these crops improves their competitive ability against weeds. Plastic mulches used in combination with trickle irrigation can also improve water use efficiency.

A disadvantage of plastic mulch is disposal at the end of the season. Many landfills do not accept plastic mulches. Photodegradable plastic mulches have been developed, but their season-long persistence has been a problem and they degrade into small pieces of plastic that contaminate the environment. Biodegradable plastic mulches are not yet widely available.

Mechanical Practices

Mechanical weed management relies on primary and secondary tillage implements such as the rotary hoe and the row cultivator. Mechanical weed management starts with seedbed preparation. Few no-till systems have been developed for vegetable crops. No-till suggestions are included in the section on reduced tillage systems.

Moldboard plowing is usually the first step in mechanically managing weeds. Moldboard plowing is particularly useful in controlling emerged annual weeds. *Rotary hoeing* is often an important second step in mechanically managing weeds in large-seeded vegetable crops (sweet corn, snap bean, lima bean, and pea). Rotary hoeing needs to be done after the weeds germinate but before they emerge. Rotary hoeing does not control large-seeded weeds such as velvetleaf and shattercane.

Once the crop has emerged or transplants are established, a *row cultivator* can be used to manage emerged weeds. Adjust the cultivator sweeps or teeth to dislodge or cover as many weed seedlings as possible. Seedling weeds can be killed by cultivating 1 to 2 inches deep. Best weed control is obtained with a

row cultivator in relatively dry soils by throwing soil into the crop row to cover small weed seedlings. Avoid crop injury from poor cultivation, which will reduce crop yields.

In some vegetable crops, such as asparagus, *mowing* can be an effective weed management tool. Mowing can prevent the production of weed seeds and kill upright weeds, reducing competition. Mowing must be carefully timed to eliminate perennial, biennial or annual weeds that would compete strongly in vegetables because of their upright growth habit. Timely, repeated mowing also helps deplete the food reserves of perennial weeds (root systems).

Mechanical control has many limitations that must be considered when designing weed management systems. Because mechanical management relies on relatively dry soil, a rainy period may prevent the use of mechanical weed management options and lead to severe weed competition. Relying entirely on mechanical practices to manage weeds is labor intensive, and many growers will use herbicides combined with nonchemical approaches to control especially difficult weeds. Some of these difficult-to-control weeds include wild proso millet in sweet corn, Canada thistle, hemp dogbane, field bindweed, quackgrass, and johnsongrass. Newly introduced problem weeds often show up in scattered patches along headlands and field borders. These are best controlled or eradicated with herbicides before large areas are infested.

Biological Practices

Currently, no management system tools exist in the Midwest for using insects or diseases to control weeds common in vegetable crops. Most biological weed management systems to date have been developed to control problem weeds in rangeland areas in the West. One biological system that has potential in the Midwest is the use of cover crops to suppress the development of weeds. These systems are still experimental, but have promise for reducing herbicide use once they are fully developed.

The most promising cover crop system is the use of winter rye. Winter rye is planted in late summer or early fall and overwintered as a cover crop. In the spring, the rye is killed with either Roundup or Poast one week prior to planting the crop. The rye is left as a mulch on the soil surface and the crop is no-till planted. The system, although experimental, does appear to provide early season control of many annual weeds.

Problems have been encountered that are still being investigated. These problems include the duration of weed control obtained, the spectrum of weeds controlled, and the requirement of herbicides to initially kill the cover crop and possibly for managing weeds that escape control by the rye. Since the system is experimental, it should be evaluated in small areas before anyone extensively adopts its use. Table 3 summarizes some of the nonchemical weed management practices (see page 22). The most effective weed management system is an integrated approach that combines many different practices. This approach must be adaptive, aiming to prevent weed problems or cope with any that occur.

Chemical Weed Management Strategies

Several herbicides are often labeled for a particular crop. Scouting your area to determine which weeds are present will allow you to select the herbicide that will give you the best control.

All the herbicides labeled for a crop are not necessarily listed in this guide. If you are unfamiliar with a herbicide, conduct a small test under your environmental conditions and cultural practices before using the herbicide extensively.

Herbicide Labels

Always Read and Understand the Herbicide Label Before Use. Reading the herbicide label is a very profitable use of your time. Information on the label will direct you to the correct uses, application methods, rates, and potential environmental hazards. Follow label directions for the best possible control with minimal crop injury and environmental contamination. The label contains restrictions on use and discusses environmental and soil conditions that affect crop injury, influence the effectiveness of weed control, and can cause nontarget site effects.

Do Not Use Any Herbicide Unless the Label States That It Is Cleared for Your Particular Use and Crop. Using a nonregistered pesticide can cause harmful residues in the vegetable crop, which can result in crop seizure and consumer injury. The label also states whether the herbicide is a restricted-use or general-use pesticide. Restricted-use pesticide labels contain a statement that the products are restricted and that only

licensed applicators can buy them and supervise their application. The information in this production guide is current as of the date of publication (November, 1992). Watch for notices of changes in the U.S. Environmental Protection Agency (EPA) registration of herbicides in the *Illinois Vegetable Farmer's Letter*, the *Pest Management and Crop Development Bulletin*, the *Iowa Newsletter for Commercial Vegetable and Fruit Growers*, or the Indiana *Vegetable Crops Hotline*.

Reduced Tillage Systems

Reduced tillage systems are a method to combat soil erosion. **Roundup** or **Gramoxone Extra** can be applied outside the normal growing season to control emerged weeds in reduced tillage systems. Weeds should be growing actively, and the application must be made before the crop has emerged. If you are applying Roundup to control perennial weeds, it is recommended that it be applied before disturbing the soil. After it is applied, Roundup must be allowed to translocate throughout the perennial weed for several days or incomplete control may result. Follow Roundup label directions carefully for the rates and timing of application. If perennial weeds are not a major problem, you can eliminate early flushes of weeds by applying Roundup or Gramoxone Extra to all weeds that emerge. Plant the crop with minimal working of the soil. Never apply Roundup or Gramoxone Extra to an emerged crop because severe crop injury or death will occur.

Roundup and Gramoxone Extra will control most annual broadleaf and grass weeds. Neither herbicide has any soil residual activity, so other weed control measures will be necessary during the growing season. Gramoxone Extra will also suppress perennials by killing their shoots, but should not be expected to control regrowth of perennial weeds from rhizomes or other underground storage organs. Roundup is better for controlling perennials because it will kill shoots and translocate to destroy underground parts. Roundup will only suppress some particularly hard-to-control perennials such as bindweed, hemp dogbane, and milkweed. To obtain control of these perennials, applications of high rates, repeat applications of Roundup (within label guidelines), or mechanical removal may be necessary.

Herbicide Rates and Guidelines for Use in Vegetable Crops

All herbicide rates given in this guide are in amount of product per broadcast acre. Adjust amounts accordingly for banded applications. Make preemergence applications before weeds emerge or after removing any weeds present. Make postemergence applications after weeds have emerged. Make stale seedbed treatments only if weeds have emerged, but no crop plants are present. The herbicide recommendations given in this guide are not intended to replace careful reading of a current herbicide label. Reregistration of older herbicides has affected the availability of many products. Some of the older herbicides not re-registered are not listed in this bulletin, but may be available, and old stocks can still be used.

Environmental and Health Hazards of Herbicides

Nontargeted effects can occur from the use of herbicides. With the increased attention directed toward nontargeted effects of pesticides, it is very important that you educate yourself about these effects and consider them when designing weed management systems. The following section contains discussions of some of the potential environmental and health hazards of herbicides.

Environmental Hazards

Adverse environmental effects from herbicides can have long-term consequences that are difficult to correct and must be avoided. Some environmental hazards, such as herbicide drift and carryover, will affect mainly your operation, while other hazards, such as water contamination, affect all residents. The following sections discuss some of the potential hazards and methods to avoid them.

Herbicide carryover. Herbicide carryover from persistent herbicides has been a particular problem to growers of vegetable crops. Persistence is dependent on herbicide characteristics (method of degradation, water solubility, and rate of application) and site characteristics (soil type, rainfall, and temperature). Avoid

carryover because correction of carryover problems once they occur is virtually impossible. The most important method to avoid herbicide carryover is to follow label rotation restrictions. Table 4 summarizes some of the label restrictions (see page 23). Always refer to the label for specific information. If differences between the table and herbicide label occur, always follow label information.

Herbicide drift. Another frequent hazard to vegetable growers is crop injury from herbicide drift. Certain herbicides, if not used correctly, can cause injury to nontarget plants. Herbicides such as clomazone (Command), dicamba, and 2,4-D can drift up to a mile and cause serious damage to grapes, tomatoes, peppers, other vegetables, fruit trees, and ornamental plants. Before spraying clomazone, dicamba, or 2,4-D, survey the area for desirable plants.

Spray only on calm days and use drift inhibitors when appropriate. Minimize drift by applying herbicides with nozzles that produce large droplets. Use an amine formulation of 2,4-D to reduce vapor drift. Spray clomazone, dicamba, and 2,4-D when the temperature is expected to be lower than 80 to 85° F for several days after treatment. Avoid applying clomazone to wet soils. Incorporate clomazone soon after application.

Spray tank residuals. Dicamba or 2,4-D residues in spray tanks can also injure susceptible vegetable crops. Carefully follow label directions for cleaning spray equipment after using dicamba or 2,4-D. If possible, do not use the same spray equipment to apply 2,4-D or dicamba that you use to apply other pesticides.

Herbicide resistance. There are now more than 50 documented reports worldwide of weeds developing resistance to herbicides. Herbicide resistance tends to occur when a persistent herbicide is used year after year in the same field. Thus, continued use of the same herbicide on a perennial crop, such as asparagus, should be avoided. Many of the resistant problems have occurred with triazine herbicides, such as simazine and atrazine. The labels of those herbicides contain information about avoiding resistance problems.

Approaches to avoid herbicide resistance combine herbicides, mechanical (cultivation), and cultural (crop rotation) weed management practices. Rotate between or use tank mixes of herbicides with different mechanisms of killing the plant. For example, in asparagus rotate between Sencor and Treflan. Use tillage to control weeds that escaped from herbicide applications. Especially important in minimizing any weed resistance that does occur is to scout your fields, paying special attention to any patches of a weed normally controlled by the herbicide.

Water quality. Residues of some herbicides such as atrazine, metolachlor, alachlor, cyanazine, and metribuzin have been found in surface and/or groundwater. The levels detected have normally been low, but contamination of water resources is a growing concern. For example, groundwater contamination from pesticides and nitrates is a particular concern in areas of the Midwest with sandy soils and shallow groundwater.

Factors determining the potential for groundwater and surface water contamination include herbicide solubility in water, rate of degradation, volatility, and tendency for the herbicide to attach to soil particles or organic matter. Herbicides that have high water solubility and long persistence are a particular concern.

Site characteristics (soil type, soil depth, water table depth, slope, and weather) also can lead to contamination of water resources from herbicides. You should be aware of the potential problem of herbicide contamination and take all possible steps to avoid contamination of surface and subsurface water resources.

Table 3. Summary of Nonchemical Weed Management Practices

PRACTICE	COMMENTS
Cultural	
• Land selection	Avoid fields with a history of weed problems.
• Crop selection	Grow the most competitive crops in fields with history of weed problems.
• Crop rotation	Rotate between vegetables and nonrow crops such as alfalfa. Rotate between vegetables in different botanical categories.
• Adapted crop varieties	Select crop varieties adapted for your area.
• Proper row spacings and plant densities	Use row spacings and plant densities that assure rapid crop canopy closure.
• Correct planting times	Plant crops when soil temperatures favor rapid germination and emergence. Do not plant warm-season crops too early in the season.
• Appropriate fertility, disease and insect management	Vigorous, healthy crops are more competitive against weeds.
• Mulch	Natural mulches are difficult to use over large acreages. Synthetic (plastic) mulches are useful to manage weeds within the row in warm-season crops. Consider disposal problems when using plastic mulches.
Mechanical	
• Moldboard plowing	Can eliminate emerged annual weeds.
• Rotary hoeing	Useful to manage small-seeded weeds in large-seeded crops such as sweet corn, snap bean, lima bean, and pea.
• Row cultivator	Dislodge or cover as many weed seedlings as possible. Avoid damaging crop root systems.
• Mowing	Mow weeds as soon as flowers appear so no viable weed seed is produced.
Biological	
• Cover crops	Still experimental. Winter rye system is the most promising and most effective against small-seeded broadleaf weeds.
• Insect or disease pests of weeds	No current systems use insects or diseases to manage weeds common to vegetables.

Table 4. Label Restrictions (in Months) on Rotating to Vegetable Crops

Herbicide	Tomato	Pea	Snap Bean	Sweet Corn	Pumpkin	Melon	Cole Crops
Soybean Herbicides							
Canopy	10[3]	FB[1]	FB	18	FB	FB	FB
Classic	15[3]	FB	FB	FB	FB	FB	FB
Command	NNY	AT	9	9	AT	9	NNY
Commence	NNY	9	9	9	9	9	NNY
Dual	18	AT	AT	AT	18	18	18
Lexone or Sencor	4-10	4-10	12	12	12	12	12
Lorox	NNY	NNY	NNY	4	NNY	NNY	NNY
New Lorox Plus	FB	FB	FB	FB	FB	FB	FB
Preview	10	FB	FB	FB	FB	FB	FB
Prowl	NY	NY	NY	AT[2]	NY	NY	NY
Pursuit	18	AT	4	18	18	18	18
Reflex	18	18	18	10	18	18	18
Salute	4	8	12	4	12	12	12
Scepter	18	18	11	18	18	18	18
Squadron	18	18	11	18	18	18	18
Tri-Scept	18	18	11	18	18	18	18
Tornado	18	18	18	10	18	18	18
Treflan	AT[3]	AT	AT	5	5	5	AT
Turbo	12	8	8	12	8	12	12
Corn Herbicides							
Aatrex and others	NNY	NNY	NNY	AT	NNY	NNY	NNY
Bicep	18	18	18	AT	18	18	18
Bladex	NY	NY	NY	AT	NY	NY	NY
Conquest	18	18	18	AT	18	18	18
Lariat	NNY	NNY	NNY	AT	NNY	NNY	NNY
Princep	NNY	NNY	NNY	AT	NNY	NNY	NNY
Prozine	NNY	NNY	NNY	AT	NNY	NNY	NNY
Sutazine	18	18	18	AT	18	18	18

[1]The rotation restrictions are in months after application.
[2]Sweet corn for processing only.
[3]Transplanted tomatoes only.

NOTE: AT = herbicide labeled for the crop or no rotation restriction exists, NY = the crop can be planted the year after application, NNY = the crop cannot be planted the following year, and FB = a field bioassay required before planting the crop.

Relative Effectiveness of Herbicides for Vegetable Crops

Ratings Key

G=Good
F=Fair
P=Poor
N=None

		Barnyard Grass	Crabgrass	Fall Panicum	Foxtails	Goosegrass	Yellow Nutsedge	Annual Morningglory	Galinsoga	Jimsonweed	Lambsquarter	Nightshade	Pigweed	Purslane	Ragweed	Smartweed	Velvetweed
PREPLANT INCORPORATED HERBICIDES	Balan	G	G	G	G	G	P	P	P	P	F	P	G	P	P	P	P
	Command	G	G	G	G	G	N	F	P	F	G	P	P	G	G	G	G
	Devrinol	G	G	G	G	G	N	N	P	N	F	N	G	G	N	P	N
	Dual	G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
	Eptam/Genep	G	G	G	G	G	F	P	P	N	F	F-P	G	G	P	P	F
	Prefar	G	G	G	G	G	N	N	N	N	F	N	F	F	N	N	N
	Prowl	G	G	G	G	G	N	N	N	N	G	P	G	G	P	P	P
	Ro-Neet	G	G	G	G	G	F	N	F	N	F	P	G	F	P	P	P
	Sutan+	G	G	G	G	G	G	N	F	N	P	N	F	P	P	P	N
	Tillam	G	G	G	G	G	P	N	F	N	F	N	F	P	P	P	N
	Treflan	G	G	G	G	G	N	F	N	N	G	P	G	G	P	P	P
PREEMERGENT SURFACE APPLIED HERBICIDES	Alanap	P	P	P	P	P	N	F	F	F	G	P	G	F	F	F	F
	Amiben	F	F	P	F	F	N	N	F	F	G	G	G	G	G	G	F
	Atrazine	G	G	P	F	G	F	F-G	G	G	G	G	G	G	G	G	F
	Antor	G	G	G	G	G	P	P	G	P	F	G	G	F	P	F	P
	Bladex	G	G	F	G	G	N	G	G	G	G	G	G	G	G	G	F
	Caparol	F	G	F	F	F	P	F	F	F	G	G	G	F	G	F	F
	Curbit	G	G	G	G	G	N	N	F	N	F	F	G	G	P	P	N
	Dacthal	G	G	G	G	G	N	N	N	P	G	N	F	G	N	N	N
	Dual	G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
	Goal	P	F	F	P	P	N	F	G	F-G	G	G	G	G	G	G	F
	Karmex	G	F	F	G	G	P	G	G	G	G	G	G	G	G	G	G
	Kerb*	F	F	P	F	F	P	P	P	P	F	P	P	G	F	F	P
	Lasso	G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
	Lexone/Sencor	F	F	F	F-G	F	N	N	G	F	G	N	G	G	G	G	G
	Lorox	F	F	F	F	F	N	P	G	F	G	F	G	G	G	G	G
	Pyramin	F	F	F	F	F	N	P	P	F	F	G	G	G	G	G	F-G
	Ramrod	F	G	G	G	G	N	P	F	N	F	G	G	G	P	P	N
	Sinbar	G	G	G	F-G	G	P	F-G	G	G	G	G	F-G	G	G	G	G
	Surflan	G	G	G	G	G	N	F	N	N	G	P	G	G	P	P	P
POSTEMERGENT HERBICIDES	Atrazine + oil	G	G	F	F-G	G	G	F-G	G	G	G	G	G	G	G	G	G
	Basagran	N	N	N	N	N	G	F	G	G	F	P	P	F-G	F	G	G
	Bladex	G	F	P	G	G	N	F	G	P	G	G	F	G	G	G	P
	Buctril	N	N	N	N	N	N	G	N	G	G	G	F	P	G	G	G
	Caparol	F	F	F	F	F	N	F	G	G	G	G	G	G	G	F	G
	2,4-D	N	N	N	N	N	N	G	G	F	G	G	G	P	G	P	F
	Fusilade	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
	Goal	P	P	P	P	P	N	F	G	G	F	G	E	G	G	F	F
	Gramoxone	G	G	G	G	G	G	G	F-G	G	G	G	G	G	G	G	G
	Lexone/Sencor	F	F	F	F	F	N	F-G	G	F	G	P	G	G	G	G	G
	Lorox	F	F	F	F	F	N	G	G	F	G	G	G	G	G	G	G
	Poast	G	F-G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
	Roundup	G	G	G	G	G	F	G	G	G	G	G	G	G	G	G	G
	Spin-aid	N	N	N	N	N	N	F	G	F	G	F	P	G	G	G	F
	Stoddard Solvent	G	G	G	G	G	F	G	F	G	G	G	G	G	N	G	G

*Excellent against quackgrass

Herbicides Registered for Use on Midwest Vegetables in 1993*

	Alanap	Antor	Atrazine	Balan	Basagran	Bladex	Buctril	Command	Curbit	Dacthal	Devrinol	Diquat	Dual	Eptam, Genep	Eradicane Extra	Evik	Fusilade	Goal	Gramoxone Super	Karmex
Asparagus											X						X		X	X
Beet		X																		
Broccoli										X	X							X	X	
Cabbage										X	X							X	X	
Carrot																	X			
Cauliflower										X	X							X	X	
Collard										X									X	
Cucumber	X								X	X									X	
Dill																				
Eggplant										X	X								X	
Endive																				
Escarole																				
Horseradish										X										
Kale																			X	
Lettuce				X															X	
Lima Bean					X					X			X	X					X	
Mint					X		X											X		
Muskmelon	X								X	X									X	
Mustard																			X	
Onion							X			X							X	X		
Parsley																				
Parsnip																				
Pea					X			X					X						X	
Pepper								X			X								X	
Potato												X	X	X		X			X	
Pumpkin								X	X										X	
Radish																				
Rhubarb																				
Snap Bean					X					X			X	X					X	
Spinach		X																	X	
Squash								X	X										X	
Sweet Corn			X		X	X							X		X					
Sweet Potato										X							X			
Tomato											X								X	
Turnip										X										
Watermelon	X								X	X									X	

* Check label directions to assist you in the use of the above herbicides.

Herbicides Registered for Use on Midwest Vegetables in 1993*

	Kerb	Lasso	Lexone, Sencor	Lorox	Poast	Prefar	Prowl	Pyramin	Ramrod	Ro-Neet	Roundup	Sinbar	Spin-Aid	Stoddard Solvent	Sutan+	Tillam	Treflan	2,4-D
Asparagus			X		X						X	X					X	X
Beet								X		X	X		X					
Broccoli					X						X						X	
Cabbage					X						X						X	
Carrot			X	X										X			X	
Cauliflower					X						X						X	
Collard					X						X						X	
Cucumber					X	X					X							
Dill														X				
Eggplant					X						X							
Endive	X																	
Escarole	X																	
Horseradish											X							
Kale					X						X						X	
Lettuce	X				X	X					X							
Lima Bean					X		X				X						X	
Mint												X						
Muskmelon					X	X					X							
Mustard					X						X						X	
Onion											X							
Parsley														X				
Parsnip				X							X							
Pea		X			X				X		X						X	
Pepper					X						X						X	
Potato			X	X	X		X				X							
Pumpkin					X				X		X							
Radish											X							
Rhubarb																		
Snap Bean					X		X				X						X	
Spinach					X					X	X							
Squash					X				X		X							
Sweet Corn		X					X		X		X				X			X
Sweet Potato											X							
Tomato			X		X						X					X	X	
Turnip											X							
Watermelon					X	X					X							

* Check label directions to assist you in the use of the above herbicides.
[1] Processing sweet corn in Illinois Only

Common Names of Registered Herbicides

Common Name	Trade Name	Producer	Formulation
alachlor	Lasso, Stall	Monsanto	4E
ametryn	Evik	Ciba-Geigy	80W
atrazine	many	many	many
benefin	Balan	Dow Elanco	1.5LC
bensulide	Prefar	ICI	4E
bentazon	Basagran	BASF	4S
bromoxynil	Buctril	Rhone Poulenc	2E
butylate	Sutan (Sutan + with antidote)	ICI	6.7E
clomazone	Command	FMC	4E
cyanazine	Bladex	DuPont	4L
cycloate	Ro-Neet	ICI	6E
DCPA	Dacthal	Fermenta	75W
Diethatyl	Antor	NOR-AM	4E
diquat	Diquat	Valent	2E
diuron	Karmex	DuPont	80DF
endothal	Desi-Cate	Atochem	0.52S
EPTC	Eptam	ICI	7E
ethalfluralin	Curbit	Dow Elanco	3EC
fluazifop-butyl	Fusilade 2000	ICI	1E
glyphosate	Roundup	Monsanto	3EC
imazethapyr	Pursuit	American Cyanamid	2E
linuron	Linex, Lorox	Griffin, DuPont	50DF
MCPB	Thistrol	Rhone-Poulenc	2EC
metolachlor	Dual	Ciba-Geigy	8E
metribuzin	Sencor, Lexone	DuPont, Mobay	4F, 4L
napropamide	Devrinol	ICI	50DF
naptalam	Alanap	Uniroyal	2L
oxyfluorfen	Goal	Rohm and Haas	1.6E
paraquat	Gramoxone Extra	ICI	2.5E
pebulate	Tillam	ICI	6E
pendimethalin	Prowl	American Cyanamid	4E
phenmedipham	Spin-Aid	NOR-AM	1.3E
pronamide	Kerb	Rohm and Haas	50W
pyrazon	Pyramin	BASF	67.7DF
sethoxydim	Poast	BASF	1.5E
2,4-D Amine	many	many	many
terbacil	Sinbar	DuPont	80W
trifluralin	Treflan	Dow Elanco	4E

Managing diseases effectively involves making the best possible decisions to reduce the risk of serious disease-related losses. The strategies upon which effective management is based are those of disease prevention and slowing the spread of diseases. That is, with a given season or over several seasons, the objective is to prevent disease outbreaks and the development of severe early season epidemics. Several options for achieving this objective are discussed below.

Disease Diagnosis

Accurate diagnosis of crop disorders is an essential first step in disease management. Knowledge that certain diseases occur regularly in particular fields can be helpful when planning for future crops. The chances for errant decisions regarding the use of fungicides for protection or remedial treatment are greatly reduced with knowledge of diseases and their symptoms. Even the ability to distinguish between infectious (those which can be spread from plant to plant) and non-infectious (nutrient imbalances, herbicide injury, etc.) disorders is valuable in making disease control decisions because diagnosis in the field often involves eliminating unlikely possibilities first. Growers who have a reasonably good understanding of the types of infectious and non-infectious disorders that can occur have a better chance of making the correct disease control decisions.

Healthy Plant Material

One of the fundamental prerequisites for a healthy crop is the use of healthy seed or transplants. A crop started with infected or infested plant material will result in low yields with poor quality and often will cost more to produce because of wasted efforts at chemical control. Also, the diseased crop may thoroughly contaminate a field and could remove it from production for an extended period of time. Although diseases are occasionally introduced via contaminated seed from seed companies, the commercial seed companies remain the most reliable source of plant material. Saving vegetable seeds for next year's crop is not recommended. There has been a recent trend throughout the Midwest towards local greenhouse production of transplants. Although local transplant production offers advantages in environmental control over the crop and an escape from chronic southern soilborne diseases, there will be offsetting disadvantages in the risk of spread of seedborne disease and other diseases endemic to northern states.

Disease Resistant Varieties

The use of disease resistant varieties is among the most reliable and least expensive disease control options. Although resistant varieties may not be as productive as traditional susceptible varieties, the lower yields may be offset by the fact that disease-related losses will be reduced or eliminated. There are other advantages to using resistant varieties. If varieties that are resistant to a soilborne disease are used, then a long-term decline in the pathogen population can be expected, especially if implemented in combination with reasonably long crop rotations. If varieties resistant to a foliar disease are planted, then considerable savings from reduced fungicide applications can be expected. Unfortunately, resistant varieties do not exist for all diseases on all vegetable crops, so it is important to take advantage of such options when they are available.

Resistance may be complete, where no disease symptoms occur, or incomplete, where disease symptoms occur, but the severity of the disease is much reduced compared to susceptible varieties. Examples of diseases to which complete resistance is expressed include Fusarium wilt of tomato, Fusarium yellows disease of cabbage, and powdery mildew of muskmelon. Examples of diseases to which incomplete resistance is expressed include black rot of cabbage, Phytophthora blight of pepper, tomato anthracnose, and smut of sweet corn. It is possible for pathogen populations to overcome the complete type of resistance and result in a major disease outbreak. The chance of this occurring is rare, however, and should not prevent growers from using these varieties. Incomplete resistance is most effective when used in combination with other control methods.

Tillage and Crop Rotation

Many plant pathogens overwinter in association with crop residue and are unable to survive once the crop residue is decomposed. Tillage (especially fall tillage) helps control disease by reducing the amount of inoculum that survives the winter. Rotating fields to different crops each year helps control disease by

avoiding the build-up of certain plant pathogens in the soil. The longer the rotation, the less likely that a severe early season disease outbreak will occur. It is important to rotate to unrelated crops, e.g. tomatoes to cucurbits, cucurbits to crucifers, crucifers to sweet corn, etc. Crop rotation used in combination with effective tillage methods and resistant varieties offers a great opportunity to reduce the dependence on fungicides for disease control.

Some soilborne diseases are unaffected by rotation. Such diseases are caused by pathogens that produce resilient survival structures that can withstand the effects of time and non-host crops. Examples include Phytophthora blight, Fusarium wilt, and root knot nematode. Others have such a broad host range that they survive indefinitely because so many crop and weed species serve as hosts. Examples include Sclerotinia, Rhizoctonia, and Verticillium. Also, there are some important pathogens that are not affected by tillage or crop rotation because they overwinter in Gulf Coast states. Examples include sweet corn rust and downy mildew of cucurbits. Decisions regarding tillage and crop rotation should be made with consideration that although rotation is a good general practice to improve or maintain good soil tilth, tillage (especially fall tillage) is often not in accord with recommended soil management and conservation practices.

Other Cultural Practices

Other practices, such as altering time of planting, modifying irrigation methods or scheduling, use of raised beds, and altering plant density can also be used to make conditions less favorable for disease. For example, planting seeds only in warm, well-drained soils can reduce levels of seedling diseases caused by *Pythium* and other soilborne fungi.

Chemical Control: Fungicides, Bacteriacides, Nematicides, Fumigants

The decision to apply chemicals for disease control can save a crop from certain economic loss or can result in a waste of financial resources. The difference in the results of such a decision often depends upon the user's understanding of the nature of the disease in question. Knowing which disease is present is of primary importance; once understood, the grower only has to select the appropriate product for treatment and read and follow label directions.

Fungicides can be classified as protectants or eradicants. A protectant fungicide is designed to serve as a chemical barrier to infection by plant pathogenic fungi. Protectant fungicides are not absorbed by the plant and do not "burn out" existing infections. Their purpose is only to prevent successful spore germination and infection. Once an infection has occurred, a lesion will develop and produce more spores, despite the presence of a protectant fungicide. Because the fungicide deposit must come into contact with a germinating spore to be effective, incomplete coverage of the plant surface by the fungicide can result in unexpectedly high levels of disease. Therefore, for a protectant fungicide to be effective, it should be applied repeatedly throughout the season, and in such a manner as to achieve acceptable coverage of the crop. Protectant fungicides are often referred to as "broad spectrum" fungicides because they traditionally have been effective against diverse groups of plant pathogenic fungi.

Eradicant fungicides are also called "systemic" fungicides because they are absorbed into the plant where they are able to eradicate existing infections. Advantages of using eradicant fungicides are that coverage of plant surfaces does not need to be as extensive as with protectant fungicides, and that they do not need to be applied as often. Disease scouting programs can often be used if an eradicant fungicide is available. Unfortunately, eradicant fungicides have been developed for only a few pathogens. Also, if these fungicides are not used properly, they can prompt the development of new strains of some pathogens that are resistant to the fungicide. In order to maintain the effectiveness of eradicant fungicides, they usually are applied as a tank mix with a broad spectrum, protectant type of fungicide. The need for fungicide applications can be affected by several factors, including the following: weather conditions (moisture and temperature), levels of host resistance, stage of crop development, as well as the levels of pathogen inoculum. A more complete understanding of how these factors affect the disease process can allow the grower to use fungicides more efficiently and effectively.

Bacteriacides (copper and antibiotic compounds) can play a role in reducing the risk of early-season bacterial disease epidemics. Copper compounds also are mediocre fungicides and are handled similarly to protectant fungicides. They will be effective only if disease incidence is very low prior to the initial application and if protection is maintained during

Disease Management Strategies (cont.)

extended periods of disease-favorable weather. Antibiotics serve a similar purpose in certain crops. Normal summers in mid western states include periods of warm, rainy weather that are ideal for the increase and spread of bacterial diseases. Because bacterial diseases spread so rapidly, chemical control alone is not sufficient to protect against severe epidemics. Bacteriacides are most effective when used in conjunction with other control methods.

Nematicides and fumigants are designed to reduce populations of nematodes and soilborne fungi before the crop is planted. Like other disease control chemicals, they are most effective when used in combination with cultural control options such as extended crop rotations and resistant varieties.

Fungicide Reference Guide for Selected Vegetable Diseases*

	anilazine	basic copper sulfate	benomyl	chlorothalonil	copper hydroxide	copper resinate	iprodione	mancozeb	maneb	metalaxyl	thiophanate M	TPTH	triadimefon
ASPARAGUS													
Phytophthora													
rust								X	X				
BEAN													
anthracnose		X		X									
common blight		X			X	X							
halo blight					X	X							
rust				X									
white mold			X				X				X		
BROCCOLI, CABBAGE, CAULIFLOWER													
Alternaria leafspot		X		X	X				X				
blackleg							X						
blackrot		X											
downy mildew		X		X	X	X			X	X			
CARROT													
Alternaria leafspot		X		X	X		X					X	
Cercospora leafspot				X								X	
CUCUMBER, MUSK-MELON, WATERMELON													
Alternaria leafblight		X		X	X	X		X	X				
angular leafspot		X			X	X							
anthracnose		X	X	X	X			X	X				
downy mildew		X		X	X	X		X	X	X			
gummy stem blight				X				X	X				
powdery mildew			X								X		X

*Fungicides registered for control of specific diseases are indicated by "X."

Fungicide Reference Guide for Selected Vegetable Diseases*

	anilazine	basic copper sulfate	benomyl	chlorothalonil	copper hydroxide	copper resinate	iprodione	mancozeb	maneb	metalaxyl	thiophanate M	TPTH	triadimefon
ONION													
Botrytis (blast)			X				X	X	X				
downy mildew			X			X		X	X	X			
purple leaf blotch			X				X	X	X				
PEPPER													
anthracnose									X				
bacterial spot	X			X	X								
Cercospora leafspot	X								X				
Phytophthora blight									X	X			
POTATO													
early blight	X		X	X			X	X	X			X	
late blight	X		X	X	X			X	X	X		X	
SQUASH, PUMPKIN													
anthracnose	X	X	X										
black rot			X					X	X				
downy mildew			X					X	X	X			
powdery mildew		X									X		X
SWEET CORN													
northern leaf blight			X					X	X				
rust			X					X	X				
TOMATO													
anthracnose	X		X					X	X				
bacterial speck	X			X	X								
bacterial spot	X			X	X								
early blight	X		X	X	X			X	X				
gray leafspot	X		X					X	X				
late blight	X		X					X	X	X			
Septoria leafspot	X		X		X			X	X				
Sclerotinia stem rot	X												

*Fungicides registered for control of specific diseases are indicated by "X."

Common Names of Registered Fungicides

Common Name	Trade Name	Producer	Formulation
benomyl	Benlate	DuPont	50DG
	Orthocide	Chevron	50WP, 80WP
chlorothalonil	Bravo 720	ISK-Biotech	6F
	Bravo W-75	ISK-Biotech	75WP
	Bravo 90DG	ISK-Biotech	90DG
	Bravo C/M	ISK-Biotech	27DG
DCNA	Botran	TUCO	75WP
dinocap	Karathane	Rohm & Haas	25WP, 4LC
fosetyl-AL	Aliette	Rhone Poulenc	80WP
iprodione	Rovral	Rhone Poulenc	50WP
mancozeb	Dithane M-45	Rohm & Haas	80WP
	Dithane DG	Rohm & Haas	4F
	Manzate 200 DF	DuPont	80 DG
	Penncozeb	ATOCHEM	80WP
	Penncozeb DF	ATOCHEM	75DG
maneb	Maneb 80	ATOCHEM	80WP
	Manex	Griffin	4F
metalaxyl	Ridomil 2E	Ciba-Geigy	2F
	Ridomil MZ-58	Ciba-Geigy	58WP
	Ridomil/Bravo	Ciba-Geigy	81W
	Ridomil PC 11G	Ciba-Geigy	11DG
thiophanate M (thiophanate methyl)	Topsin M	Pennwalt	70WP, 4.5F
TPTH (triphenyltin hydroxide)	Du-Ter	Griffin	**30F
	Super-tin	Griffin	4F
triadimefon	Bayleton	Mobay	50WP
*basic copper sulfate	Basicop	Griffin	53WP
	Triangle	Phelps-Dodge	53WP
	Tribasic Copper Sulfate	Citco	53WP
*copper hydroxide	Kocide 101	Griffin	50WP
	Kocide 606	Griffin	4.5F
	Kocide DF	Griffin	61 DF
	Champion	Agtrol	50WP
*copper resinate	Citcop 5E	Tennessee Chemical	**5EC

ABBREVIATIONS:

WP = wettable powder, DG = dispersible granules, F = flowable suspension, LC = liquid concentrate, EC = emulsifiable concentrate.

* The number preceding the type of formulation for *copper* products indicates the percentage or amount of *metallic copper* in the product. For example, "53WP" describes a wettable powder product that is 53 percent metallic copper, and "3F" describes a flowable product containing 3 lbs. of metalic copper per gallon.

** For TPTH, the "30F" formulation indicates that the product contains 30 oz. of active ingredient per gallon. For copper resinate, the "5EC" formulation indicates that the product contains 5 percent metallic copper.

FORMULATION NOTES:

Fungicides are sold commercially as a mixture of active ingredient (that which kills the fungus) and other substances, i.e., carriers, diluents, solvents, wetting agents, emulsifiers, etc. The *formulation* indicates the portion of the product which is active ingredient and the physical form of the product. For WP and DG formulations, the number before the abbreviation indicates the percentage of the product that is active ingredient. For F, LC, and EC formulations, the number before the abbreviation (usually **) indicates the amount of the product that is active ingredient. For example, "50WP" describes a wettable powder that is 50% active ingredient, and "4F" describes a flowable product that contains 4 pounds of active ingredient per gallon of product.

Soil Treatment for Disease and Nematode Control

Seedling diseases, root diseases and vascular wilts caused by soilborne fungi and nematodes can be destructive problems in the field and greenhouse. In many cases, soil applied fumigants or nematicides can help prevent serious losses to soilborne disease when used in conjunction with long-term disease management practices. Soil fumigants have been tested on several Iowa vegetable crops, but unlike Indiana and Illinois, have not been consistently beneficial. For Iowa, crop rotation, particularly with field corn and soybeans, is very effective.

Soil fumigants are chemicals that, when injected into the soil, emit toxic fumes that penetrate air spaces in soil in sufficient concentration to kill microorganisms. They must be sealed into the soil with water or a plastic tarp to ensure that a lethal concentration and exposure time is reached. Because fumigants are harmful to all living plants, a period of 2 weeks to 2 months must be allowed between treatment and planting in order to avoid crop damage. Several nonfumigant nematicides are available for several vegetable crops. These generally are systemic compounds that also may provide good insect control.

A number of different factors affect the performance of these products, including soil temperature, soil moisture, soil tilth, organic matter, soil type, and time of application. Consult the product label for specific details on safe handling and application methods.

A brief description of several common soil treatments is given in the table below.

Fumigant/Nematicide	Application and Comments
1,3-D; 1,3-Dichloropropene and related chlorinated hydrocarbons (Telone, etc.)	Preplant soil treatment only. For broadcast treatment, apply with chisel or plow sole equipment. Using 12 inch spacing between chisels. Allow 2 to 3 weeks between treating and planting. Follow manufacturer's directions.
Methyl Bromide	Primarily a plant bed treatment. Preplant treatment only. Generally applied as gas under gas-proof tarps. Expose soil to fumigation for 24 to 48 hours. Aerate soil and wait 2 to 14 days before planting. Follow manufacturer's directions. Approved for vegetable plant beds (production of transplants only) and preplant treatment of tomato acreage.
Methyl Isothiocyanate; formulated 20% methyl isothiocyanate and 80% chlorinated hydrocarbons (Vorlex).	For broadcast treatment, apply with chisel or plow sole equipment. Use water seal, tarp or plastic. After sealing, leave undisturbed for 4 to 7 days at soil temperatures above 60°F or for 1 or 2 weeks at lower temperatures. Aerate soil and wait 2 to 3 weeks or until all odor is gone before planting. Some methyl isothiocyanate combination products may be used at soil temperatures as low as 35°F. Row applications may not be effective for severe nematode infestations. Follow manufacturer's directions.
SMDC; Sodium Methyldithiocarbamate (Vapam, etc.)	Preplant soil treatment only. Used alone or in water as a soil fumigant. May be applied by soil injection, through sprinkler system, in check or flood irrigation water. Also may be applied uniformly over soil surface with sprinkling can, hose proportioner, or sprayer and then watered in. Apply gas-proof plastic cover or use water seal. Aerate 5-7 days after application and allow an additional 7-14 days before planting; up to 30 days may be required if soil temperature below 60°F. Follow manufacturer's directions.
Vydate; oxamyl (non-fumigant)	Soil and foliage treatment. Registered for control of nematodes in carrot, celery, cucurbits, eggplant, pepper, potato, sweet potato, and tomato. Use according to label directions. Foliar applications have limited efficacy.
Nemacur; fenamiphos (non-fumigant)	Soil treatment only. Registered for use on cabbage, Brussels sprouts, and okra.

CROP RECOMMENDATIONS

ASPARAGUS

HYBRID VARIETIES

All male hybrids: Jersey Giant, Jersey Knight, Jersey King, Jersey Prince (grows best on heavier soils), and Greenwich.
Other hybrids: Jersey Centennial (50% male) and Synthetic 4-56 (85% male).
For trial only: Jersey Gem, Limburgia.

Hybrid varieties have improved vigor, disease tolerance, and higher yields, and are grown from seeds or crowns. Order well in advance.

PLANTING, SPACING, CULTIVATING

Crowns: Use only 1-year old crowns. Transplant April 15 to May 15. Use 5-foot rows with crowns 16 inches apart. Set the crowns in 8 to 10 inch furrows in light soils and 5 to 6 inch furrows in heavy soils. Cover with 2 to 3 inches of soil. Select deep, well-drained sandy loam soils. Hybrids should be planted slightly deeper. Start cultivating when spears begin to emerge, and continue periodically until furrows are level at end of first season.

AGE FOR HARVESTING

Harvest only 2 or 3 times in spring 1 year after transplanting. Thereafter, harvest for about 2 months in the spring. Allow the ferns to grow after this period to accumulate food reserves for the next season.

FERTILIZING

Broadcast before beds are worked in the spring with 50:100:100 (lb. per acre) N : P_2O_5 : K_2O. Topdress after harvest with 50:0:0 (lb. per acre) N : P_2O_5 : K_2O. Before planting new crowns, test soil and apply 100 lb. per acre of 8-32-0 in bottom. Response to nitrogen remains questionable in some soils. Cover with 1 inch of soil before setting crowns.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Fusarium crown and root rot	Dip roots in a captan solution (3 lb. captan 50WP per 100 gal.) before planting.	Obtain crowns from a reliable source. Avoid fields with a history of crown and root rot. Disease is promoted by acid (low pH and poorly drained, infertile soil).
Rust	Fungicides recommended for rust control include Dithane M-45, Manzate 200DF, and Penncozeb at 2 lb. per acre, or Dithane DF at 2 lb. per acre.	Apply protective fungicides after harvest at 7-10 day intervals. Protection of ferns during summer months is essential for good yields the following season.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Devrinol 50DF	4 lb. per acre on light-colored soils (less than 2% organic matter); 8 lb. on other soils.	Incorporate 1 to 2 in. before weed emergence. Prior to planting succeeding crops, deep moldboard or disc plow. Do not seed alfalfa, small grains, sorghum, corn or lettuce for 12 months after using Devrinol.

* For specific weeds controlled by each herbicide, check table on page 23.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE (cont.)		
Karmex 80DF	2 lb. per acre on light-colored soils (less than 2.0% organic matter), 4 lb. Karmex on other soils. Use at least 25 gal. of water per acre.	Use after tillage or chopping fern in the spring and again after harvest, if necessary. Apply before weeds emerge. Total dosage should not exceed 4.8 lb. AI per acre per year Karmex. 6-8 wk. residual activity. DO NOT apply to young plants during first year.
Lexone 4L or Sencor 4F	1 to 2 qt. per acre	Apply after tillage or chopping fern in spring and again after harvest, if necessary. Apply before weeds emerge. Total dosage may not exceed 2 lb. AI per acre per year. 2 sprays are necessary for season-long sandbur control. 6-8 wk. residual. 14 day PHI.
Sinbar 80W	1.5 lb. per acre on coarse soils and 3.0 lb. per acre on other soils. Do not use on soils with less than 1% organic matter. Use lowest rate on sandy or sandy-loam soils.	Apply prior to spear emergence in spring or after clean cutting. Do not use more than 3.0 lb. per acre per year. Do not plant any other crop than asparagus within 2 years of herbicide application. 8-12 wk. residual activity. For seedlings apply 300 lb. per acre activated charcoal in a 1 in. band over rows at planting.
Treflan 4E	1 to 1.5 qt. per acre	Use higher rates on heavier soils. Apply and incorporate 1 to 2 in. early in spring when spears are at least 4" below soil surface. Good grass control. 4-6 wks. residual activity.
POSTEMERGENCE		
2,4-D (Sodium or amine form only)	2 lb. AI per acre (check product label).	Spray on emerged weeds before, during, or after the harvest season. The spray during harvest season should be made immediately after harvest to minimize injury. Use drop nozzles for treatments after harvest to avoid spraying the fern.
Poast 1.5E	1.5 to 2.5 pt. per acre plus 1 qt. COC per acre.	Use high rate on quackgrass.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
STALE SEEDBED		
Gramoxone Extra 2.5E	2 to 3 pt. per acre plus 1 pt. nonionic surfactant per acre.	Apply before crop emergence or after last harvest. 6 day PHI. RUP.
Roundup (3 lb./gal)	2 to 4 qt. per acre.	Apply at least 7 days before first spears emerge in spring or immediately after the last harvest when all spears are snapped off. If spears are allowed to regrow, delay application until ferns have developed. Delayed treatments must be applied as a directed or shielded spray. Direct contact of the spray with asparagus fern may result in serious crop injury.

* For specific weeds controlled by each herbicide, check table on page 23.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Asparagus beetles and cutworms.	For control on spears during harvest, use one of the following to prevent egg laying and feeding injury:	
	Sevin 80SP at 1.25 to 2.5 lb., or 50WP at 2 to 4 lb. per acre, or 5D at 20 to 40 lb. per acre, or 5B at 40 lb. per acre.	Do not treat more than once every 3 days. 1 day PHI. Dust for beetles only. Bait for cutworms only.
	OR	
	Lorsban 4E at 2 pt. per acre.	Do not make more than 1 application. Broadcast with ground equipment. 1 day PHI.
	OR	
	Cythion or Malathion 57EC at 2 pt. per acre.	Will not control cutworms. 1 day PHI.
	OR	
	Lannate 1.8L at 2 pt. or 90SP at 1/2 lb. per acre.	Double rate for white cutworm. 1 day PHI.
	OR	
	Methoxychlor 2EC at 2 to 4.5 qt. per acre.	For beetle control. 3 day PHI.
	OR	
	Ambush 2EC at 6.4 fl. oz., or 25WP at 6.4 oz. per acre	Apply by ground equipment only, using at least 25 gal. of water per acre to give sufficient coverage of plants. Do not apply Ambush at more than 0.4 lb. AI per acre per season.
	OR	
	Pounce 3.2EC at 2 to 4 fl. oz. per acre.	Do not exceed more than 4 applications of Pounce per season. 3 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Asparagus beetles and cutworms (continued)	Rotenone 1D at 25 to 30 lb. per acre.	1 day PHI.
	For control on seedlings and fern growth after harvest is over, use one of the following (use lower rates for seedlings):	
	Sevin 80SP at 2.5 to 5 lb., or 50WP at 4 lbs., or 5D at 40 to 60 lb. per acre.	Apply after harvest has stopped. Do not treat more than once every 3 days.
	OR	
	Lannate 1.8L at 2 to 4 pt. or 90SP at 0.5 to 1 lb. per acre.	Apply after harvest has stopped.
	OR	
	Methoxychlor 2EC at 2 to 4.5 qt. per acre.	For beetle control. 3 day PHI.
	OR	
	Rotenone 1D at 25 to 30 lb. per acre.	Apply after harvest has stopped.

BROCCOLI, CABBAGE, CAULIFLOWER, AND BRUSSELS SPROUTS

BROCCOLI Varieties*	Season	Comments
Green Comet	Early	Excellent center head and large side shoots
Emperior F_1	Early-Mid	Produces few side shoots
Green Valiant	Mid	Good firm center head
Premium Crop	Mid	Large center heads, few side shoots
Goliath	Mid	Large tight heads

For Trial Only: Galaxy (early-mid), Cruiser (early), Packman (early), Baccus (early, very uniform).
For Fall Trial: Galaxy, Paragon (large, uniform)

CABBAGE Varieties*	Season	Head Size	Yellows Resistance	Remarks
Stone Head	Very Early	Small	No	Solid head for an early type
Head Start	Early	Medium	No	Excellent field holding for an early type
Market Prize	Main	Medium-Large	Yes	Will tip burn under some conditions
Roundup	Late	Large	Yes	May show signs of tip burn
Gourmet	Late	Medium-Large	Yes	Fair to good holding ability
Titanic 90	Late	Large	Yes	Good tip burn tolerance
Blue Pak	Main	Medium-Large	No	Good tip burn tolerance
Red Acre	Main	Small	No	A firm head
Ruby Ball	Early	Medium	No	Very early for a red cabbage

For Trial Only: Applause. Red types for trial: Red Head, Red Rookie, Solid Red 781

* All varieties listed are hybrids.

CAULIFLOWER Varieties	Season	Comments
Snow Crown-F_1 Hybrid	Early	Good and reliable for spring and early fall production
Self-Blanche op	Late	Does not need tying if plants are fertilized properly
Snowball 123 op	Mid	Forming heads need to be blanched
Andes op	Main	Forming heads need to be blanched
White Sails	Main	Forming heads need to be blanched
For Trial Only:		
Snow King	Early	Best for early fall production
Snowflower	Mid	Good yielder, needs to be blanched
Majestic-F_1 Hybrid	Early	Good early spring and fall producer in southern Indiana

SPACING

Cabbage for Market: Rows 2 to 3 ft. apart. Plants 12 in. apart in row.
Cabbage for Kraut: Rows 3 ft. apart. Plants 18 in. apart in row.
Broccoli: Rows 2.5 to 3 ft. apart. Plants 12 to 18 in. apart in row.
Cauliflower: Rows 3 ft. apart. Plants 15 to 24 in. apart in row.

Raised beds (6 in. high, 40 in. wide with 2 rows 11 in. apart on beds) may be desirable under certain conditions.

FERTILIZING

Application Method	N*	P_2O_5	K_2O
		(lb./acre)	
Broadcast and plow down	0	60	180
Preplant	160	0	0
or			
preplant	100	0	0
and			
sidedress	60	0	0

Set each plant with 0. 5 pt. starter solution. Solutions include 3 lb., 10-52-17 or equivalent, in 50 gal. water; or 1 gal. 10-34-0 in 100 gal. of water. Soil pH should be 6.0 to 6.8 on mineral soils and 5.5 to 5.8 on organic soils.

* Excessive fertilization, particularly with nitrogen may result in too rapid growth and hollow flower stalks in broccoli. Hollow stem in broccoli can be reduced by closer spacing and proper nitrogen levels.

HARVESTING

Broccoli: Harvesting is done by hand while the head is still compact and before the flowers open. The central heads should be dark blue or green and 4 to 6 in. across when mature. If harvesting too late or when the heads are overmature, woodiness in the stems will develop. Depending upon your marketing requirements, the main head is cut with 8 to 10 in. of stem. Sometimes a second harvest of side shoots can be obtained. If broccoli is to be processed, it is cut with less attached stem (6 to 7 in.) and with few or no leaves. Fresh market broccoli is cut longer, with little trimming done. Quality of broccoli is based upon the degree of compactness, leafiness, trimness of heads, damage, and freedom from insect and extraneous debris.

Cauliflower: When ready to harvest, the heads should be compact and clear white. Heads become discolored and develop an undesirable flavor when exposed to sunlight. The longest leaves are normally tied loosely together over the head to "blanch" and prevent the head from being exposed to the sun. The desirable size for harvest is a diameter of approximately 6 in. Larger heads usually cannot be obtained by delaying harvest. Instead, proper cultivar selection and plant spacing should be considered. Cauliflower is hand-harvested and cut with 1 or 2 whorls of leaves to protect the head.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Alternaria leaf spot	3-4 year crop rotation	Rotate to noncruciferous crops.
	Foliar application of a fungicide such as Bravo 720 (1.5 pt. per acre) or Bravo 90DG (1.25 lb. per acre).	Apply protective fungicides at the first sign of disease and repeat at 7-10 day intervals.
	Maneb	Several maneb fungicides available.
Black leg	3-4 year crop rotation	Rotate to non-cruciferous crops.
	Plant disease free seeds or transplants.	Hot water seed treatment helps eliminate seed-borne pathogens.
	Apply Rovral 50W (2 lb. per acre) or Rovral 4F (2 pt. per acre) to young plants (2-4 leaf stage) immediately after thinning. **Broccoli only.**	A second application may be made until the day of harvest.
Black rot	3-4 year crop rotation	Rotate to non-cruciferous crops.
	Plant disease resistant cabbage varieties.	Resistant varieties include: Bravo, Green Cap, Olympic, and Solid Blue #770.
	Plant disease free seeds or transplants.	Hot water seed treatment helps eliminate seed-borne pathogens.
	Apply 2 lb. of fixed copper per acre. Repeat applications at 5-7 day intervals if wet weather persists early in the season.	Applications of copper may slow the spread of black rot.
Club root	Plant only disease free transplants.	Avoid poorly drained soils with a history of club root.
	7 or more year crop rotation.	Rotate to non-cruciferous crops.
	Drench transplants with 3 to 6 lb. Terrachlor 75WP in 100 gal. water. Apply 0.3 to 0.75 pt. per plant.	Serious losses can be avoided by raising soil pH to 7.2 - 7.5.
Downy mildew	2-3 year crop rotation.	Rotating to non-cruciferous crops may reduce pathogen populations and increase fungicide efficacy.
	Plant disease resistant broccoli varieties.	Resistant broccoli varieties include: Citation, Everest, Mariner.
	Apply Ridomil/Bravo 81W (1.5 lb. per acre) at the first sign of disease.	Second and third applications may be required and should be applied at 14 day intervals.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Fusarium yellows	Plant yellows-resistant varieties.	
Seed contamination	Use 1 oz. Captan 50WP per 100 lb. of seed.	Most seed companies distribute treated seeds. Hot water treatment is important to help prevent black leg and black rot.
Wirestem	Apply Terrachlor 75W to seedbeds (4 to 8 oz. per 500 gal. water per 1000 sq. ft. of soil surface).	Raise seedlings in seed beds that are disinfected by steam or chemical fumigants.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Dacthal 75WP	8 lb. on light-colored soils (less than 2% organic matter), 14 lb. on darker colored soils in at least 50 gal. water per acre.	Apply immediately after seeding or transplanting. Use 50-mesh or larger screens. Not effective on muck soil and other high organic soils.
Devrinol 50DF	2 lb. per acre on light-colored soils (less than 2% organic matter), 4 lb. on other soils.	Incorporate 1 to 2 in. deep before seeding or transplanting. After harvest or prior to planting succeeding crops, a deep mold-board or disc plowing operation must be done. Do not seed alfalfa, small grains, sorghum, corn, or lettuce for 12 months after application.
Treflan 4E	1 pt. per acre on light-colored soils (less than 2% organic matter), 1.5 pt. on darker soils.	Apply before planting and incorporate immediately into soil by double discing or with other equipment to give thorough mixing 3 to 4 in. deep. Not effective on muck and other high organic soils.
Goal 1.6E	1.25 to 2.5 pt. per acre (0.25 to 0.5 lb. per acre) in a minimum of 20 gal. water. Use lower rate on coarse textured soils.	Apply after completion of soil preparation but prior to transplanting. Transplant within 7 days of application. Do not use on direct seeded broccoli, cauliflower, cabbage, or over the top of existing plants. DO NOT APPLY TO BRUSSELS SPROUTS.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

Weed Control (cont.) Broccoli, Cabbage, Cauliflower, & Brussels Sprouts

Herbicide*	Treatment**	Comments
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Maximum of 3 pt. per acre per season. 30 day PHI.
STALE SEEDBED		
Gramoxone Extra 2.5E	2 to 3 pt. per acre plus 1 pt. nonionic surfactant per acre.	Apply before crop emergence. RUP.
	OR	
Roundup (3 lb./gal)	2 to 3 qt. per acre.	Apply to emerged weeds before planting in spring or after harvest in fall. Check label for specific weeds controlled and for recommended rates.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS Controlled	Treatment	Comments
Root maggots	Cabbage maggot injury is usually more severe when fields have decaying organic matter present, such as plowed down cover crop, or when cool, wet conditions prevail.	
	For use in transplanting water, mix any one of the following in each 50 gal. of water: (refer to Comments or product label regarding drench application):	*The transplant mixture* (insecticide plus water) application will require about 200 to 300 gal. of water per acre, based upon the number of plants set per acre.
	Lorsban 4EC as follows: cauliflower - 1.6 to 2.4 fl. oz. per 1000 linear feet of row; broccoli, Brussels sprouts, and cabbage at 1.6 to 2.75 fl. oz. per 1000 linear feet of row.	Apply as a water-based spray directed to base of the plants immediately after setting in field using a minimum of 40 gal. of total spray per acre. Do not apply as a foliage application. 30 day PHI.
	OR	
	Diazinon AG500 a 0.25 to 0.5 pt. or Diazinon 50WP at 0.25 to 0.5 lb. in 50 gal. of water (for drench application).	Transplant water treatments may reduce stands due to plant stress at time of transplanting. Make drench application at the rate of 1/2 to 1 cupful per plant, either by hand or tractor mounted sprayer with drop nozzles to direct spray to base of plant.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Root maggots (cont.)	Dyfonate 4EC at 1 to 2 qt. per acre (drench).	Mix in 200 to 400 gal. of water per acre. Using drop nozzles, apply a drenching spray to base of plants immediately after transplanting.
Caterpillars Imported cabbage worms Cabbage loopers Diamondback moth larvae Cross-striped cabbageworm	Use *one* of the following when tiny worms and/or loopers first appear:	Monitor for cabbage loopers and diamondback moths with pheromone traps.
	Bacillus thuringiensis (MVP, Javelin, Dipel, Thuricide, Biobit). Follow label directions.	Begin applications when worms are small. Good coverage must be maintained. 0 day PHI. Use of BT products will help conserve beneficial insects.
	OR	
	Thiodan 50WP at 1.5 to 2 lb. or 3EC at 1 to 1.3 qt. per acre.	Cabbage and broccoli 7 days; Brussels sprouts and cauliflower 14 day PHI. For control of cabbage loopers, cabbage worms, and aphids. Do not apply more than 2 applications per year.
	OR	
	Lannate 1.8L at 2 to 4 pt., or 90SP at 0.5 to 1 lb. per acre. Add wetting agent.	Cabbage 1 day PHI; cauliflower, broccoli, and Brussels sprouts 3 day PHI. Follow label directions. Also controls aphids.
	OR	
	Pounce 3.2EC at 2 to 4 fl. oz., or 25WP at 3.2 to 6.4 fl. oz. per acre.	Do not apply more than 0.8 lb. AI per acre per season to broccoli, cauliflower, Brussels sprouts; or more than 1 lb. AI per acre per season for cabbage. 1 day PHI.
	OR	
	Ambush 2E at 3.2 to 6.4 fl. oz., or 25WP at 3.2 to 6.4 oz. per acre.	
	OR	
	Larvin 3.2AF at 16 to 40 fl. oz. per acre.	Do not exceed 240 fl. oz. per acre per season. 7 day PHI. Not for Brussels sprouts.
	OR	
	Monitor 4EC at 1 to 2 pt. per acre.	PHI: Cauliflower 28 days; Brussels sprouts 14 days; cabbage 35 days; broccoli 21 days high rate, 14 days for low rate. Also controls aphids.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not exceed 0.4 lb. AI per acre per season. Do not use on Brussels sprouts. 3 day PHI. Also controls aphids.
	OR	
	Orthene 75S at 1.3 lb. per acre.	For Brussels sprouts and cauliflower only. Do not apply more than 8 lb. per acre per season to Brussels sprouts. Use 25 to 150 gal. spray or 5 gal. by air. Do not feed to livestock or allow grazing in treated areas. 14 day PHI. Also controls aphids.
	OR	
	Dibrom 8EC at 2 pt. per acre.	Use 1 pt. for aphids. Refer to label. 1 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Aphids	Conserve natural enemies.	Limiting the use of insecticides other than *Bacillus thuringiensis* products will conserve predators and parasites that help keep aphid populations under control.
	Use one of the following as needed:	
	Diazinon AG500 at 1 pt. per acre.	Repeat applications at 7-10 day intervals are usually required. 7 day PHI.
	OR	
	Cygon 400 at 0.5to 1 pt. per acre.	Repeat applications as necessary. Do not use on Brussels sprouts. Cauliflower and broccoli 7 days; cabbage 3 day PHI.
	OR	
	Metasystox-R 2SC at 1.5 to 2 pt. per acre.	Do not apply more than 3 times per season. 7 day PHI for cabbage, broccoli, and cauliflower. 10 day PHI for Brussels Sprouts.
	OR	
	Orthene, Thiodan, Monitor, or Dibrom as described for cabbage caterpillars.	Follow all harvest restrictions (PHI), warnings, and precautions on label.
Flea beetles	Any of the materials applied for worm control should adequately control flea beetles, except *Bacillus thuringiensis* (MVP, Javelin, Dipel, Thuricide, Biobit).	Examine plants soon after they are set in the field to determine need for control. Small holes in leaves and the presence of tiny black jumping beetles may destroy newly set plants.
	OR	
	Sevin 50WP at 1 lb. or 80SP at 0.6 lb. per acre.	3 day PHI.
Thrips	Plant resistant varieties.	Some varieties of cabbage are resistant to thrips.
		Thrips will often build up to high levels in small grains. Watch for thrips moving to cabbage when grains dry down or are harvested.
		Thrips may be especially severe during hot, dry weather.
	Diazinon AG500 at 1 pt. per acre.	7 day PHI.
	Pounce 3.2 EC at 2 to 4 fl. oz., or 25WP at 3.2 to 6.4 fl. oz. per acre.	Do not apply more than 0.8 lb. AI per acre per season to broccoli, cauliflower, Brussels sprouts: or more than 1 lb. AI per acre per season for cabbage. 1 day PHI.
	OR	
	Ambush 2E at 3.2 to 6.4 fl. oz., or 25WP at 3.2 to 6.4 oz. per acre.	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not exceed 0.4 lb. AI per acre per season. Do not use on Brussels sprouts. 3 day PHI.

MUSKMELON Varieties	Season	Quality	Fusarium Wilt* Resistance	Remarks
Burpee Hybrid	Early-Mid	Very Good	3	Appropriate for northern Indiana
Classic	Mid	Excellent	3	Heavy net
Gold Star	Early	Fair-Good	3	Appropriate for northern Indiana and Iowa
Harper Hybrid	Early	Good	3	Western type. Good for roadside sales
Legend	Mid	Very Good	7	Oblong shape, large and uniform fruit
Saticoy	Late	Excellent	8	Very firm flesh; sutured with a light net
Starship	Early-Mid	Very Good	9	Excellent size and net, uniform fruit
Superstar	Early	Good	9	Very large fruit, excellent netting

Promising midwestern types: Rising Star, Cordele (early to mid-season).
Western melons: Allstar, Mission, Hiline.
Green flesh muskmelons: Rocky Sweet, Mediterranean Delight (Makdimmon), Galia. These melons have a yellow gold netted exterior with a sweet creamy green flesh. Most ripen within a very short time period, thus, plantings should be staggered throughout the season. These types perform best under drier conditions. Avoid heavy soils with poor drainage.
Honeydew and Crenshaw melons for trial: Limelight, Early Dew, Moonshine.

WATERMELON Varieties	Maturity (days)	Fusarium Wilt* Resistance	Color	Shape	Approx. wt. (lb.)
Charleston Gray	90-95	2	light green	long oval	26-32
Crimson Sweet	85-90	5	green striped	blocky round	20-30
Crimson Tide	85-90	7	green striped	blocky round	20-30
Jubilation	85-95	9	lt. green striped	blocky	20-35
Madera	85-95	5	green striped	blocky round	25-35
Oasis	85-90	9	green striped	blocky round	25-35
Royal Jubilee	90-95	8	green striped	long oval	25-35
Royal Star	85-90	7	green striped	blocky oval	25-35
Royal Sweet	85-90	7	green striped	blocky oval	20-35
Sangria	85-95	9	dk. green striped	long blocky oval	20-30
Starbrite	85-95	8	green striped	blocky oval	20-35

Suggested Small Ice-box Variety (Iowa): Mickeylee
Suggested Jubilee-type trial varieties: Regency, Starbrite
Suggested Crimson Sweet-type trial varieties: Mirage, Fiesta
Seedless Varieties:** Crimson Trio, King of Hearts, Queen of Hearts (not recommended for Iowa), Scarlet Trio, Tiffany
Yellow-Flesh Varieties For trial: Sunshine, Yellow Baby

* **Fusarium Wilt Resistance Ratings for Muskmelon and Watermelon:** a score of "9" indicates excellent resistance, a rating of "1" indicates little or no resistance. Cultivars with a resistance rating less than "6" should not be planted in fields with a history of Fusarium wilt. See Purdue Extension publication BP-19 for a more extensive list of wilt-resistant muskmelon and watermelon varieties.

** Pollinators must be planted with seedless varieties. Use a long watermelon such as Royal Jubilee or Sangria as the pollinating variety. Crimson Sweet works well as a pollinator, but its fruit will be seeded and have a similar appearance to most seedless varieties.

A. CUCUMBER – Slicing Varieties	Season	Disease Resistance*
Marketmore 80	Early	3-4
Pacer	Early	3-4
Poinsett	Early	1-2-5-6
Slicemaster	Early	1-2-3-4-5-6
Superslice	Early	3-4
Victory Hybrid	Early	1-2-3-4-5-6

For Trial Only: Raider, Sprint 440-11, Maximore, Speedway, and Striker.

B. CUCUMBER – Pickling Varieties	Season	Spine Color	Disease Resistance*
Bounty	Early	Black	1-2-3-4-5-6
Calypso	Early to Mid	White	1-2-3-4-5-6
Carolina	Mid	White	1-2-3-4-5-6
Green Spear 14	Mid	White	1-3-4-5-6
Triplemech**	Early	White	1-2-3-4-5-6
Score**	Early	White	1-2-3-4-5

* Degree of resistance varies according to variety. Disease resistance codes are as follows: 1) angular leaf spot, 2) anthracnose, 3) cucumber mosaic virus, 4) scab, 5) downy mildew, 6) powdery mildew.

** Machine harvest only.

SPACING

Muskmelons: Rows 5 to 7 ft. apart. Plants 3 to 5 ft. apart in row. 1 t o 2 plants per hill. Plastic mulch is recommended. Clear mulch is suggested only for earliest plantings in northern areas.

Watermelons: Rows 6 to 12 ft. apart. Plants 4 to 6 ft. apart in row. One plant per hill. Plastic mulch is recommended.

Cucumbers: Rows 4 to 6 ft. apart. Plants 8 to 15 in. apart in row. Pickles (Machine harvest): Rows 18 to 20 in. apart. Plants 5 to 7 in. apart in row. Cucumbers should be planted after the danger of frost is past since they are not frost tolerant. For proper germination, soil temperature must be *above* 60°F. Planting too early when the soil is too cold and wet will result in poor seedling emergence.

FERTILIZING

Application Method*	N**	P_2O_5	K_2O
	(lb/acre)		
Watermelon:			
Broadcast and plowdown	60	60	120
or			
Muskmelon and Cucumber:			
Broadcast and plowdown	90	60	120
or			
Muskmelon:			
Broadcast	60	60	120
Side-dress after setting	45	0	0

* Be sure to test your soil annually for pH and lime requirements. Apply recommended rate of lime to adjust pH to 6.0 to 6.5. Muskmelon in particular is very sensitive to low pH soil. If your soil test indicates that only a low level of magnesium is present, be sure to apply the recommended amount of magnesium via your limestone or in another form.

** Do not use anhydrous ammonia or solutions containing free ammonia during growing season. *Hill-dropping fertilizer is definitely not recommended.* It is recommended that at least half of the nitrogen applied be in the nitrate (NO_3) form.

IRRIGATION

Cucumbers: Maximum yields and fruit quality will only result if the plants receive *adequate* and *timely* moisture. Depending upon your soil type, approximately 1 to 2 inches of water per week is needed to obtain high quality cucumbers. An irregular water supply, particularly during blossoming and fruit development, can detrimentally affect fruit quality and result in increased nubins or hooked fruit.

Muskmelons: Muskmelon moderately deep rooted and require adequate soil moisture with good drainage. Natural rainfall may not be adequate. Supplemental irrigation may be required, particularly in the early stages of growth. When irrigating, irrigate the soil in the effective root zone to field capacity. A good steady moisture supply is critical for good melon production. After melons have attained a good size, it is best if irrigation is reduced. Reduced irrigation at this time can in some cases increase the sugar content of the mature fruit. Excessive moisture during fruit ripening can result in poorer fruit quality.

Watermelons: Watermelons are deep rooted plants, so natural rainfall often is adequate and irrigation may not be cost effective on heavier soils. Adequate soil moisture in the early growth stages will help to ensure vigorous growth and is also critical during blossoming and fruit development.

HARVESTING

Cucumbers: Unless a once-over mechanical harvester is being used, cucumbers should be harvested at 2-4 day intervals to prevent losses due to oversized and overmature fruit. Desired harvest size ranges from 5 to 8 in. long and 1.5 to 2 in. in diameter for fresh market. If growing for a processor, be sure to understand the specific terms of their contract at the beginning of the growing season. Prices received are related to the quantity of fruit within specific size ranges as established by either USDA guidelines or by a processor.

Muskmelons: Harvesting is done manually and great care must be exercised at picking to harvest only the physiologically mature plants. Fruits must be in the half or full slip state. Fruit harvested prior to the half slip stage will be too green and will *not* ripen properly. The shipping of undermature fruit has been a problem and should be avoided.

Watermelons: Harvesting watermelons at the correct stage of maturity is critical and difficult. While each cultivar is different, maturity can be determined in several ways. Ground spots changing in color from white to yellow, browning of tendrils nearest the fruit, ridges on the rind surface, and a hollow or dull sound when "thumped" all indicate correct maturity. Melons should be cut from the plant to avoid vine damage and prevent stem-end rot.

DISEASES Controlled	Treatment	Comments
Bacterial fruit blotch	Plant uncontaminated watermelon seed. If fruit blotch has occurred in the past, sanitize the greenhouse thoroughly. Contaminated fields should be fall-plowed and planted to crops other than melon or cucurbits for at least 2 years. Subsequent grain crops are suggested for the rotation so that broadleaf herbicides will kill volunteer watermelon seedlings in the spring.	The pathogen is primarily seed-borne (introduced with contaminated watermelon seed), but may overwinter on infested plant material in greenhouses and in the field. Muskmelons may be infected, but they do not appear as disease-prone as watermelons.
	In situations where fruit blotch is discovered in the field, weekly applications of copper hydroxide may help reduce the reate of spread of the disease.	Copper applications may be effective in reducing losses only if the disease is diagnosed early, and sprays are applied before widespread infection has occurred. Repeated use of copper will result in an reduction of watermelon yield. Copper will not provide acceptable control of fungal diseases such as anthracnose or gummy stem blight.
Damping off (Pythium)	*For field seeded crops*: Apply Ridomil 2E at 2 to 4 pt. per acre as a preplant broadcast spray in 50 gal. of water before or at time of seeding. Calibrate equipment accordingly for band applications over the row. *For transplant production*: Use Subdue 2E at 1 to 2 fl. oz. per 1350 sq. ft. immediately after seeding. Irrigate after application.	Seeds should be treated with captan or thiram (about 1/2 tsp. per lb. seed) before planting. Most seed companies deliver pre-treated seed. Check the seed package to determine the kind of seed treatment used. If no treatment was applied, then use chemical seed treatment.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Alternaria leaf blight (muskmelon)	3-4 year crop rotation.	Rotation with noncucurbit crops will significantly reduce the threat of Alternaria in future melon crops.
	Bravo 720 at 2 to 3 pt. per acre. 0 day PHI. OR Bravo 90DG at 1.5 to 2.5 lb. per acre. 0 day PHI. OR	Apply protective fungicide beginning when vines touch within rows or at first sign of the disease. Use a 7 day application interval.
	mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or Penncozeb DF at 2 to 3 lb. per acre. 5 day PHI.	Manex II is an alternative mancozeb fungicide for those who prefer the flowable formulation.
Angular leaf spot (cucumber and muskmelon)	Resistant varieties (cucumbers only) OR	Several cucumber varieties have genetic resistance to angular leaf spot.
	Citcop 5E at 3 pt. per acre. 0 day PHI. OR Kocide 101 at 2 to 3 lb. per acre. 0 day PHI. OR Champion WP at 2 to 3 lb. per acre.	Apply copper bacteriacides at the first sign of disease. Alternate or tank mix with fungicides to maintain protection from other diseases. Sprays will result in marginal chlorosis of cucurbit leaves.
Anthracnose (cucumber, muskmelon, watermelon)	Resistant varieties (cucumbers only)	Many cucumber varieties have genetic resistance to anthracnose.
	3-4 year crop rotation.	Rotation with non-cucurbit crops will decrease the threat of anthracnose in future years.
	Bravo 720 at 2 to 3 pt. per acre; 5-7 day interval. 0 day PHI. OR Bravo 90DG at 1.5 to 2.5 lb. per acre. Use a 5-7 day spray interval. 0 day PHI. OR	Apply fungicides at the first sign of disease or when vines touch within rows. Bravo and mancozeb fungicides protect against Alternaria and gummy stem blight infection as well as against anthracnose.
	mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or Penncozeb DF at 2-3 lb. per acre. 5 day PHI.	Manex II is an alternative mancozeb fungicide for those who prefer the flowable formulation.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Anthracnose (cont.)	Benlate at 8 oz. per acre; 7-10 day interval. 0 day PHI. OR Topsin-M at 8 oz. per acre. 7-10 day spray interval. 0 day PHI.	Benlate and Topsin may be effective against anthracnose but leave crops vulnerable to Alternaria leaf blight and gummy stem blight. If these products are used, they should be tank mixed with Bravo or a mancozeb fungicide.
Bacterial wilt (cucumber and muskmelon)	A systemic insecticide (Furadan) should be incorporated into soil before transplanting. Contact insecticides such as Sevin, Thiodan, or Methoxychlor should be applied to seedlings before transplanting and then continued on a regular basis after the systemic insecticide loses effectiveness (4-5 weeks).	Control of this disease depends on control of striped and spotted cucumber beetles. Fields should be scouted regularly for the presence of beetles. Insecticides should be applied only when beetles are present. When large numbers are present, treatments may be required twice weekly.
Downy mildew (cucumber, muskmelon, watermelon)	Resistant varieties Ridomil/Bravo 81W at 1.5 lb. per acre. 5 day PHI. OR Bravo 720 at 2 to 3 pt. per acre. 7 day spray interval. 0 day PHI. OR Bravo 90DG at 1.5 to 2.5 lb. per acre. 7 day spray interval. 0 day PHI.	Several cucumber varieties have genetic resistance to downy mildew. Apply Ridomil/Bravo at the first sign of disease. Use 14 day application interval. Most fungicides that protect against Alternaria and gummy stem blight also provide some downy mildew protection.
Fusarium wilt (muskmelon and watermelon)	Use resistant muskmelon cultivars: Superstar, Legend, and Saticoy. Use resistant watermelon cultivars: Sangria, Oasis, Jubilation, Royal Sweet, Royal Star, and Royal Jubilee.	These cultivars have good resistance to strains of Fusarium found in Indiana and Illinois. Check wilt resistance table on page 44.
Gummy stem blight (cucumber, muskmelon, watermelon)	3- 4 year crop rotation Bravo 720 at 2 to 3 pt. per acre. 0 day PHI. OR Bravo 90DG at 2 lb. per acre. 0 day PHI. OR mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or Penncozeb DF at 2 to 3 lb. per acre. 5 day PHI.	Rotation with non-cucurbit crops will decrease incidence of wilt. Rotation with other crops will significantly decrease the threat of gummy stem blight in future years. Use disease-free seed and clean, uncontaminated growing trays for raising seedlings. Disease is most severe on watermelon. Apply protective fungicides beginning when vines touch within rows or at the first sign of disease. A 7 day spray interval is recommended.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Nematodes (muskmelon and watermelon)	Telone II at 16 gal. per acre. OR Vorlex at 12 gal. per acre. OR Vydate L at 1 to 2 gal. per acre in 20 gal. water broadcast. Incorporate 2 to 4 in. deep.	Manex II is an alternative mancozeb fungicide for those who prefer the flowable formulation. Fumigate soil in spring, 2-3 weeks before planting. Apply in spring before planting. Can also be applied as a foliar treatment 2-4 weeks after planting and repeated 2-3 weeks later.
Powdery mildew (cucumber and muskmelon)	Resistant varieties Bayleton at 2 to 4 oz. per acre. 10-14 day spray interval. 0 day PHI. OR Benlate at 8 oz. per acre. 7-10 day spray interval. 0 day PHI. OR Topsin 85WDG at 4 oz. per acre. 7-10 day spray interval. 0 day PHI.	Many cucumber varieties are resistant to powdery mildew. Cantaloupe varieties resistant to powdery mildew include Legend, Summet, and Saticoy. Make initial fungicide application at approximately 7 days before first harvest for muskmelon. A second application is recommended at 2-3 weeks after the first.
Scab (cucumber)	Resistant varieties 3-4 year crop rotation mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or penncozeb DF at 2-3 lb. per acre. 5 day PHI. OR Bravo 720 at 2 to 3 pt. per acre. OR Bravo 90DG at 2 lb. per acre.	Several cucumber varieties are resistant to scab infection. Rotation will significantly reduce the threat of scab infection in subsequent cucumber crops. Apply fungicides on a 7 day schedule. 0 day PHI.
Virus diseases	Apply insecticides for aphid and cucumber beetle control since viruses are transmitted by these insects.	Several virus diseases including cucumber mosaic virus, watermelon mosaic virus, squash mosaic virus, and zucchini yellow mosaic virus can occur in the Midwest. Squash mosaic virus is seed transmitted. Inspect seedlings and discard those with virus-like symptoms. Obtain seed from reliable sources.

Herbicide*	Treatment**	Comments
PREEMERGENCE		
Alanap 2L	6 to 8 qt. per acre. Use lower rate on light colored sandy soils (less than 1% organic matter).	Normally tank mixed with Prefar. Use Alanap alone on soil to be covered with plastic mulch. A second broadcast application of Alanap made just before plants vine will give some control of emerged broadleaves.
Prefar 4E	4 qt. per acre on light-colored sandy soils (less than 1% organic matter), 6 qt. on other soils.	Apply before seeding or transplanting and incorporate lightly.
Curbit 3EC	3 to 4 pt. per acre. Requires signing a waiver of liability before using.	Direct seeded: Use low rate on light soil. Apply to soil surface within 2 days of seeding. Do not incorporate. Needs 1/2 in. rain or irrigation within 5 days to activate. If no rain occurs, cultivate shallow. Heavy rainfall or irrigation after application may cause crop injury. Transplants: Apply as a banded spray to soil between rows of plastic mulch. Do not apply over or under hot caps, row covers, or plastic mulch. Do not broadcast over top of plants.
Dacthal 75WP	8 lb. per acre on light colored soils (less than 1.5% organic), 14 lb. on darker colored soils in at least 50 gal. water.	Apply to soil (no emerged weeds) after muskmelons have 4 to 5 true leaves. Apply to moist soil or irrigate lightly after application to improve weed control. May be applied between rows of plastic mulch.
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grasses. Maximum of 3 pt. per acre per season. 14 day PHI.

* For specific weeds controlled by each herbicide check table of page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
STALE SEEDBED		
Gramoxone Extra 2.5E	2 to 3 pt. per acre plus 1 pt. nonionic surfactant per acre.	Watermelon and muskmelon only. Apply prior to, during, or after planting, but before crop emerges. RUP.
Roundup (3lbs./gal)	2 to 3 qt. per acre.	Apply to emerged weeds before planting the crop. Wait 3 days before planting.
FUMIGATION (Muskmelons in plastic)		
Vorlex	Fumigate with 12 to 15 gal. per acre.	Fumigate 3 weeks prior to transplanting. Lay plastic during or immediately after fumigating. Most weeds will be controlled under clear plastic in the southern Midwest on lighter soils. Some weeds may emerge under clear plastic in the central and northern Midwest on heavier soils.

* For specific weeds controlled by each herbicide check table of page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Seed corn maggots and cucumber beetles in seed beds	Treat seeds with a combination fungicide-insecticide, such as captan-lindane, at 1 oz. per 25 lb. of seed.	Early clean plowing of cover crops will generally result in less damage to seedling plants in the field.
	AND	
	Spray emerging seedlings with a mixture of 3 tablespoons methoxychlor 50WP per 2 gal. of water *plus* an approved fungicide at a rate for 2 gal. of water.	This is enough spray to treat one 10-sash bed, or about 400 sq. ft. Do not expect a fumigant used on the soil-manure mixture before seeding to protect seedling plants since flies can continue to lay eggs after plant emergence. Use low pressure when spraying to avoid seedling injury.
Cucumber beetles Apply at planting (either at seeding, or time of transplanting).	Furadan 15G at 24 oz. per 1000 linear feet of row (13.3 lb. per acre, based on 60-inch row spacing). NOTE: FURADAN 4F is not registered nor recommended for this use either by ground or aerial application.	Apply in a furrow or a T-band and incorporate into the top 3 in. of soil. This application is for seedling protection and beetle control after seedlings emerge or as transplants become established.

INSECTS Controlled	Treatment	Comments
Cucumber beetles and other insects listed on the labels Apply during and after seedling emergence and, for protection of plants, throughout the season when beetles are present.	Apply one of the following for seedling protection:	If Furadan 15G was applied just before or during transplanting, plants will need one spray to protect plants until plant uptake of Furadan has occurred. Fields should be monitored frequently (2-3 times per week) to detect mass emergence of beetles in the spring. Insecticide applications should be focused on periods of heavy beetle activity.
	Sevin 50WP at 2 lb., or 80SP at 1.25 lb. per acre.	Some phytotoxicity may result when carbaryl is applied during hot humid weather, especially on seedlings and newly set plants. Carbaryl may be highly toxic to bees visiting plants during bloom. 0 day PHI.
	OR	
	Methoxychlor 2EC at 2 to 6 qt. per acre.	Relatively non-toxic to bees. 7 day PHI.
	OR	
	Diazinon AG500 at 1 pt., or 50WP at 1 lb. per acre.	3 day PHI for melons, 7 days for cucumbers.
	OR	
	Thiodan 50WP at 2 lb., or 3EC at 1 qt. per acre.	2 day PHI. Do not exceed 6 applications or 3 lb. AI per acre per season.
	OR	
	Ambush 2EC at 6.4 to 12.8 fl. oz., or 25WP at 6.4 to 12.8 oz. per acre.	Apply by ground equipment using sufficient water to obtain full coverage of foliage. Do not apply more than 1.6 lb. AI per acre per season. 0 day PHI.
	OR	
	Pounce 3.2EC at 4 to 8 fl. oz., or 25WP at 6.4 to 12.8 oz. per acre.	Apply a minimum of 4 gal. finished spray per acre by air or 20 gal. finished spray per acre with ground equipment. 1 day PHI.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not exceed 0.25 lb. AI per acre per season. 3 day PHI.
Aphids	Conserve natural enemies	Limiting the use of insecticides will conserve predators and parasites that help keep aphid populations under control.
	Monitoring	Look for the presence of predators or parasitized aphids. Several predators per aphid colony will probably bring the aphid population under control without insectide.
	Apply one of the following when infestations begin to build up:	
	Thiodan 50WP at 1 to 2 lb. or 3EC at 0.6 to 1.3 qt. per acre.	2 day PHI
	OR	
	Cygon 400 at 1 pt. per acre.	Do not use on cucumbers. 3 day PHI.

INSECTS CONTROLLED	TREATMENT	
Aphids (cont.)	Apply one of the following when infestations begin to build up:	
	Metasystox-R 2SC at 2 pt. per acre.	14 day PHI for muskmelon (no more than 3 applications per season), 7 days for watermelons (no more than 2 applications per season), and 0 days for cucumbers (no more than 2 applications per season).
	OR	
	Cythion or Malathion 57EC at 1.5 pt. per acre.	Do not apply unless plants are dry. 1 day PHI.
Mites	Kelthane 35WP at 1 to 1,6 lb. per acre.	2 day PHI. Ground application only.
	OR	
	Cygon 400 at 1 pt. per acre.	Do not use on cucumbers. 3 day PHI.

EGGPLANT

Variety	Season	Comments
Dusky	Extra-early	Good but low yielding because of small fruit size.
Classic	Early	Long, slim, tapered.
Harris Special Hibush	Main	Excellent shape and color.
For Trial Only: Regal and Epic		

FERTILIZING

Broadcast and plowdown 60:60:120 of $N:P_2O_5:K_2O$.

SPACING

Rows: 3 to 5 ft. apart. Plants: 2 to 3 ft. apart in a row.

GROWING TRANSPLANTS AND TRANSPLANTING

The best transplants are fairly large, slightly hardened, 8 to 10 week old plants grown in 2 in. or larger pots. Optimum temperatures for growing the plants in the greenhouse are 70 to 75°F. A few days at 60 to 65°F are sufficient for hardening. Set plants in the field when frost danger has passed, when the soil has warmed, and when the average daily temperature reaches 65°F.

Eggplants are very responsive to the use of plastic mulches in the Midwest. Black plastic is recommended because no herbicides are available for use with clear plastic. Clear plastic is preferred for earliness and could be tried with soil fumigation (see Soilborne Disease and Nematode Control, page 33); however, some weeds will tend to grow under clear plastic when heavier soils are fumigated.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Verticillium wilt	Avoid fields with a history of Verticillium wilt. Rotate with small grains where possible.	Use of long rotations out of solanaceous crops will prevent rapid increase of pathogen populations.
	Fumigate with Vorlex (20 to 30 gal. per acre) or Vapam (60 gal. per acre) under plastic mulch.	Allow at least 30 days between application of fumigant and transplanting.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Dacthal 75WP	8 lb. per acre on light-colored soils (less than 1.5% organic matter), 14 lb. on darker colored soils in at least 50 gal. water per acre.	Apply 4- 6 weeks after transplanting. Can be sprayed directly over the transplants. Cultivate and remove all weeds before making application.
Devrinol 50DF	2 lb. per acre on light soil (less than 2% organic matter) and 4 lb. per acre on other soils.	Apply before transplanting. Incorporate 1 to 2 in. Prior to planting succeeding crops, a deep moldboard or disc plowing must be done. Do not seed alfalfa, small grains, sorghum, corn, or lettuce for 12 months after using Devrinol.
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Maximum of 4.5 pt. per acre per season. 20 day PHI.
STALE SEEDBED		
Gramoxone Extra 2.5E	2 to 3 pt. per acre plus 1 pt. nonionic surfactant per acre.	Apply before crop emerges. RUP.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated

INSECTS CONTROLLED	TREATMENT	COMMENTS
Flea beetles	Apply one of the following as needed:	
	Sevin 50WP at 2 lb., or 80SP at 1.25 lb. per acre.	0 day PHI.
	OR	
	Ambush EC at 6.4 to 12.8 fl. oz., or 25WP at 6.4 to 12.8 oz. per acre.	Do not apply more than 3 lb. AI per acre per season. 3 day PHI.
Colorado potato beetle, European corn borer	Crop Rotation	For potato beetle only. Planting fields as far as possible from last year's potato or eggplant fields will reduce potato beetle damage.
	Scouting	Regular (weekly) scouting of fields will allow you to determine the necessity for, and improve the timing of, insecticide treatments.
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not apply more than 0.35 lb. AI per acre per season. 7 day PHI.
	OR	
	Ambush 2EC at 12.8 fl. oz., or 25WP at 12.8 oz. per acre.	Apply by ground or aerial equipment, using sufficient water for uniform coverage. Do not apply more than 3.2 lb. AI per season. Apply as needed. 3 day PHI.
	OR	
	Pounce 3.2EC at 8 fl. oz. per acre.	
	OR	
	Thiodan 50WP at 1 lb. or 3EC at 0.67 to 1.3 qt. per acre.	1 day PHI. Should also control aphids. Do not apply more than 1 lb. AI per acre per season.
	OR	
	M-One at 1.5 to 2.5 qt. per acre, or Trident II at 1.5 to 3.0 qt. per acre, or M-Trak at 1.5 to 4.0 qt. per acre, or Movodor at 1.0 to 4.0 qt. per acre.	*Bacillus thuringiensis* based insecticides. For control of Colorado potato beetles only. Only controls small larvae. Other materials should be used to control adults and large larvae. 0 day PHI.
	OR	
	Guthion 50WP at 1 lb., or 2S at 2 pt. per acre.	Do not apply after fruit set. 21 day PHI. Allow 7 days between applications.
Aphids	Conserve natural enemies.	Limiting the use of insecticides other than *Bacillus thuringiensis* products will conserve predators and parasites that help keep aphid populations under control.
	Metasystox-R at 2 pt. per acre.	Do not apply more than 3 times per season. Should also control mites. 7 day PHI.

Mint (Peppermint and Spearmint)

Varieties

Peppermint: Black Mitcham, Todd's Mitcham and Murray Mitcham. The latter two varieties are resistant to Verticillium wilt.

Spearmint: Scotch spearmint and Native spearmint. These two spearmints have distinctly different oils.

Planting and Rotation

The mints are grown from dormant runners (stolons) dug from existing fields in the late fall or spring. Since Verticillium wilt is an important disease problem, even with resistant varieties, growers should use disease-free stock. Certified planting stock is available. Also, careful fall plowing of established stands is important for winter protection and to reduce the incidence of mint rust and other foliar diseases.

Although the mints are perennial, stands should not be maintained longer than 3 or 4 years in a rotation program. Older stands may show a serious build-up of disease, insect and weed problems.

Irrigation has been shown to significantly increase essential oil yields both on muck and sandy soils. Yield increases have been obtained even in seasons with above average rainfall.

DISEASES Controlled	Treatment	Comments
Spearmint rust, Septoria leafspot	Bravo 720 at 1.37 pt. per acre or Bravo 90DG at 1.12 lb. per acre. Repeat spray at 7-10 day intervals for a total of 3 sprays.	For best control, mint should be fall-plowed. Begin treatment when plants are 4 to 6 in. tall; 80 day harvest restriction. Do not feed treated hay to livestock.
Verticillium wilt	Use wilt resistant varieties of peppermint (Todd's Mitcham or Murray Mitcham). Native spearmint is resistant.	Rotate plantings after no more than 3 or 4 years.

Herbicide*	Treatment**	Comments
PREEMERGENCE		
Sinbar 80WP	1 to 2 lb. per acre before mint emerges or apply 0.25 to 0.5 lb. per acre plus a surfactant or crop oil postemergence to the crop and *small* weeds.	Do not exceed 2 lb. total per acre per season. Do not apply within 60 days of harvest.
Goal 1.6E--MUCK SOILS ONLY	2.5 to 3.75 qt. in 20 to 40 gal. of water per acre. Add a nonionic surfactant at 1 qt. per acre when applied postemergence to the weeds.	Apply only to dormant spearmint and peppermint grown on muck soil (greater than 20% organic matter). Do not apply to spearmint or peppermint grown on mineral or black sand soils. Application to emerged spearmint or peppermint will result in severe injury. Apply Goal before weeds are 4 in. tall.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
POSTEMERGENCE		
Basagran 4E	1 to 2 qt. per acre post-emergence to mint and weeds.	For yellow nutsedge and Canada Thistle repeat application at 7-10 days later. A crop oil will enhance activity. Do not apply more than 4 qt. per acre per season.
Buctril 2E	1 to 1.5 pt. per acre in at least 10 gal. water per acre. Apply before weeds have more than 4 to 6 leaves. Apply when air temperatures exceed or are expected to exceed 70°F within 5 days of application.	Application should only be made on established mint which has been harvested at least one year prior to application. Do not apply within 70 days of harvest. Buctril may cause temporary stunting and leaf chlorosis when applied to growing mint. Do not apply to mint growing under stressful conditions. Check label precautions.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Cutworms, loopers	Use one of the following as needed:	
	Lannate 90SP at 1 lb. per acre or Lannate 1.8L at 4 pt. per acre.	14 day PHI.
	OR	
	Orthene 75S at 1.3 lb. per acre.	Do not apply more than 2.6 lb. per year. 14 day PHI.
	OR	
	Lorsban 4E at 2 to 4 pt. per acre.	Use lower rate when cutworm larvae are less than 3/4 inch long. 90 day PHI. Only 1 application per growing season.
Loopers	*Bacillus thuringiensis.* (MVP, Javelin, Dipel, Biobit) Follow label rates.	0 day PHI.
Flea beetle	Malathion 57EC at 1.5 pt. per acre.	7 day PHI.
	OR	
	Lannate 90SP at 1 lb. per acre. Lannate 1.8L at 4 pt. per acre.	14 day PHI. For best results, apply immediately after harvest on stubble.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Mites	Metasystox-R at 3 pt. per acre. Repeat treatment in 10-14 days.	14 day PHI. Ground application only. Apply in at least 20 gal. of water.
	OR	
	Omite 6E at 2 to 3 pt. per acre	No more than 2 applications per year. 14 day PHI.

ONION (BULB AND GREEN)

VARIETIES

Bulb — Early Harvest, Downing Yellow Globe, Spartan Banner, Spartan Gem, Spartan Bounty.
Green — Beltsville Bunching.

SPACING AND SEEDING

Rows: 15 in. apart. Transplant: 4 in. apart in rows. Seed: 4 lb. per acre.

FERTILIZING

Application Method	N	P_2O_5	K_2O
On organic soils:		(lb/acre)	
Broadcast and plow down	0	0	240
Banded 2 in. below seed	30	120	0
Sidedress by June 1	60	0	0
OR			
Broadcast and plow down	60	120	240

At seeding, spray directly on the seed a solution of 2-6-0 at 1 pint per 100 ft. row. A 2-6-0 solution is equivalent to a 1:5 dilution of 10-34-0 liquid fertilizer with water.

OR			
Broadcast and plow down	60	240	240

On muck soil with a pH of 6.0+, add 2% manganese in the dry row fertilizer. $MnSO_4$ at 30 lb. an acre can be distributed in the seed furrow (1 lb. $MnSO_4$ per 1000 ft. of row).

On mineral soils, apply an additional 80 to 100 lb. nitrogen per acre preplant.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Alternaria purple blotch and Botrytis leaf blight	3-4 year crop rotation	Rotation out of onions or related vegetables will reduce the threat of these diseases in future onion crops.
	Apply fungicides beginning when disease first appears:	
	Rovral 50W at 1.5 to 2 lb. per acre. 14 day spray interval.	0 day PHI.
	OR	
	Bravo 720 at 2 to 3 pt. per acre. 7 day spray interval.	0 day PHI. Do not use Bravo 720 on Spanish onions.
	OR	
	Bravo 90DG at 1.5 lb. per acre. 7 day spray interval.	0 day PHI. Do not use Bravo 90DG on Spanish onions.
	OR	
	mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or Penncozeb DF at 2 to 3 lb. per acre. 5 day PHI.	Manex II is an alternative mancozeb fungicide for those who prefer the flowable formulation.
Downy mildew	Ridomil MZ-58 at 1.5 to 2.0 lb. per acre. 14 day spray interval.	5 day PHI.
	OR	
	Ridomil/Bravo 81W at 1.5 lb. per acre. 14 day spray interval.	0 day PHI.
	OR	
	Bravo 720 at 2 to 3 pt. per acre. 7 day spray interval.	0 day PHI.
Fusarium basal rot	Use Fusarium-resistant varieties such as Elba Globe, Spartan Banner, and Harvestmore.	Consult seed catalogues for varietal characteristics.
Neck rot	Windrow plants until neck tissues are dry before topping and storage. Cure rapidly and properly.	Artificial drying may be necessary (forced heated air at 93-95°F for 5 days).

Herbicide*	Treatment**	Comments
PREEMERGENCE		
Dacthal 75WP	6 lb. on light-colored soils (less than 2% organic matter), 14 lb. on darker colored soils in at least 50 gal. water per acre.	Apply immediately after seeding or transplanting, or after a clean cultivation and hand weeding. Use 50-mesh or larger screens. Not effective on muck soil. Can be used up to 14 weeks after planting.
POSTEMERGENCE		
Goal 1.6E	5 to 10 fl. oz. per acre. Apply as broadcast spray in 20 to 60 gal. of water per acre after onions have at least 2 expanded true leaves.	Spray during sunny warm weather. Do not apply more than a total of 0.37 lb. (30 fl. oz.) per year. Do not apply after bulbing begins or within 60 days of harvest.
Buctril 2E	1 to 1.5 pt. per acre. Use 50 to 70 gal. of water per acre when onions have 2 to 5 true leaves.	Thorough coverage necessary. Do not use surfactants.
Fusilade 1E	1.25 to 1.5 pt. per acre plus 1 pt. nonionic surfactant per acre.	Apply to small actively growing grasses. 45 day PHI.
STALE SEEDBED		
Gramoxone Extra 2.5	2 to 3 pt. per acre plus 1 pt. per acre nonionic surfactant.	Apply before or after planting, but before crop emerges. 60 day PHI. RUP.
Roundup (3 lb./gal.)	2 to 3 qts. per acre.	Apply before or after planting, but before crop emerges.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS Controlled	Treatment	Comments
Onion maggots	For furrow treatment at planting, use one of the following:	
	Lorsban 4E at 1.1 fl. oz. per 1000 linear ft. of row as a furrow drench.	Use a minimum of 40 gal. of total drench per acre. One application per year.
	OR	
	Dyfonate II 10G at 6 oz. per 1000 linear ft. of row as a furrow application.	Use only on soils containing 10% or more organic matter.
	OR	
	Diazinon14G at 7 lb. per acre as a furrow application.	May be used on dry or green onions.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Onion maggots (cont.)	Diazinon AG500 at 1 qt. per acre.	Planting time treatment only. Apply in sufficient water to drench seed furrow planting.
	Other recommended control procedures include: Removing cull onions after harvest, planting as far as possible from fields planted to onions the previous year, and avoiding mechanical damage to onions (undamaged bulbs are more resistant to maggot damage).	
Onion thrips	Field site selection	Onion thrips can build to extemely high levels in small grains and will move to onions when the small grains dry down or are harvested. Try to avoid planting next to small grains.
	Diazinon AG500 at 1 pt. per acre.	10 day PHI. Use 100 to 200 gal. of water per acre for improved control.
	OR	
	Guthion 2S at 2 to 3 pt. per acre	Do not apply more than three times per season. 28 day PHI for dry bulbs, 14 days for green onions. Allow at least 7 days between applications for bulb onions, 10 days for green onions.
	OR	
	Ambush 2EC at 9.6 to 19.2 oz. or 25WP at 9.6 to 19.2 oz. per acre.	Bulb onions only. Use when thrips first appear. Not for rescue treatments. 1 day PHI.
	OR	
	Pounce 3.2EC at 6 to 12 oz or 25 WP at 9.6 to 19.2 oz. per acre.	Bulb onions only. Use when thrips first appear. Not for rescue treatments. 1 day PHI.

PEA

VARIETIES	Season	Comments
Greater Progress	Early	Very popular variety
Green Arrow	Mid to late	Long holding in field
Lincoln	Mid to late	Very sweet

SPACING AND SEEDING

Rows: 32 to 36 inches apart, 6 to 8 seeds per foot of row. Seed: 100 to 150 lb. per acre.

FERTILIZING

Application Method	N	P_2O_5	K_2O
		(lb/acre)	
Broadcast and plow down	60	60	120
Band at seeding	12	48	0

DISEASES CONTROLLED	TREATMENT	COMMENTS
Fusarium wilt	Use resistant cultivars.	
Root rot	Rotate fields with a history of root rot for at least 4 to 5 years.	

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Treflan 4E	1 pt. per acre on light-colored soils (less than 2% organic matter), 1.5 pt. on darker colored soils.	Apply before planting, and incorporate into soil by double discing, or with other equipment, to give thorough mixing 3 to 4 in. deep. Not effective on muck soil and other high organic soils.
Dual 8E	1.5 to 3 pt. per acre.	Apply preplant preemergence, do not incorporate.
Command 4E	1 pt. per acre.	Apply and incorporate 2 to 3 in. deep before planting. May be used in combination with other herbicides to broaden weed control spectrum.
Pursuit 2E	3 fl. oz. per acre	Do not use if applying to Treflan treated peas. **ILLINOIS ONLY.**
POSTEMERGENCE		
Basagran 4E	0.75 to 1 qt. per acre.	Apply when weeds are small and after peas have 3 pairs of leaves. Do not add COC to peas.
Pursuit 2E	2 fl. oz. per acre	Add nonionic surfactant. Peas must have at least 1 true leaf, or crop injury may result. Do not apply if Treflan has been used. **ILLINOIS ONLY.**
Thistrol 2EC	2 to 4 pt. per acre.	FOR CANADA THISTLE CONTROL. Apply when peas have developed 6 to 12 nodes and weeds are less than 3 in. tall.
Poast 1.5E	1.0 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Maximum of 4 pt. per acre per year. 15 day PHI.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
STALE SEEDBED		
Gramoxone Extra 2EC	2 to 3 pt. per acre plus 1 pt. nonionic surfactant per acre.	Apply before or after planting, but before crop emerges. RUP.
Roundup (3lb./gal.)	2 to 3 qt. per acre.	Apply before or after planting, but before crop emerges.

* For specific weeds controlled by each herbicide, check table on page 23.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Seed corn maggot	Plant seed that has been treated with diazinon or a lindane-diazinon combination.	Adult flies are attracted to rotting organic matter or freshly plowed soil.
Caterpillars (including loopers, armyworms, cutworms, and alfalfa caterpillars)	Asana XL at 2.9 to 9.6 fl oz. per acre. OR Lannate 90SP at 0.5 to 1 lb. per acre, or 1.8L at 2 to 4 pts. per acre.	Do not exceed 0.1 lb. AI per acre per season. Do not feed treated vines to livestock. 3 day PHI. Do not feed treated vines to livestock for 14 days. 1 day PHI.
Pea aphid	Cygon 400 at 0.3 pt. per acre. OR Lannate 90SP at 0.5 to 1 lb. per acre, or 1.8L at 2 to 4 pt. per acre.	Do not feed treated vines to livestock for 21 days. 1 day PHI. Do not feed vines to livestock for 14 days. 1 day PHI.

Pepper

Varieties*	Season	Fruit Shape	Yield	No. of Fruit per pound	Remarks
Bell Captain	Mid	Large Blocky	Excellent	2	Top yielder
Belmont	Early	Blocky	Good	2-3	Good yielder
BelleStar	Mid	Blocky	Very Good	2	High yielder
Cubanelle OP	Early	Long tapering	Good	3-4	Frying type
Four Corners F_1	Early	Blocky	Good	3	Very blocky fruit
Hybelle F_1	Early	Slightly tapered	Good	2-3	Top yielder
Lady Bell F_1	Early	Slightly tapered	Good	2-3	Good yielder
Marengo	Mid	Blocky	Good	2-3	Good quality and yielder
Melody	Mid	Tapered fruit	Good	2-3	Good yielder
Pick-me-quick OP	Very early	Blocky	Fair	4	Very blocky but small fruit

For Trial Only: New Ace (very early, high yielding), Ranger (early), Elisa (large, early), Rebell (tolerant to bacterial spot , early), Bell King, Camelot and Delgado.

For Yellows: Sweet Banana (turns red at maturity), Key Largo.

For Hot Peppers: Hungarian HotWax, Jalapeno (mild and hot types available), Long Thick Red, Ring of Fire, Copacabana (yellow).

* F_1=hybrid, OP=open pollination.

Spacing

Rows: 3.5 to 6 ft. apart. Plants: 18 to 20 in. apart in row.

Growing Transplants and Transplanting

Fairly large, slightly hardened 6-8 week old plants are the best transplants. These should be grown in greenhouses having 75°F daytime temperatures. Germination is rapid between 65 to 85°F, very slow at 60°F, and ceases below 55°F. A few days at 60 to 65°F are sufficient for hardening.

Transplants are often grown by seeding directly in the plant-growing flats and then thinning to about 4 sq.. in. per plant when the first true leaf appears. Larger cell sizes (No. 50 or 72) work very well to promote early yield, with smaller cell sizes (No. 100 or 120) recommended for plants to be grown for the remainder of the season. Direct-seeding in outdoor hotbeds or spotting seedlings in the plant growing flats also produce good transplants. Large-scale growers often use plants grown outdoors in southern states. An ounce of seed produces 1,500 to 2,000 good plants, and 4 oz. provides enough plants for an acre.

Set plants in the field when frost danger has passed, when the soil has warmed, and when the average daily temperature reaches 65°F. It does not pay to rush the season by planting too early. Raised beds and plastic mulch are recommended.

Fertilizing

Broadcast and plowdown in spring 100:100:200 (lb./acre) of $N:P_2O_5:K_2O$. Sidedress is not beneficial if plants are normal size and adequate N is applied as preplant. Urea or calcium nitrate is recommended. Set plants with a starter solution of 3 lb. 10-52-17 or equivalent dissolved in 50 gal. water. Use 0.5 pt. solution per plant.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Anthracnose	Apply Maneb 80 (1.5-3.0 lb. per acre) or Maneb Plus Zinc F4 (1.2 to 2.4 qt. per acre) at first sign of disease. Repeat on a 7-10 day interval.	Use disease-free and/or transplants. Practice a 3-4 year crop rotation.
Bacterial spot	Use Agri-strep (1 lb. per 100 gal. water) to protect seedlings in seedbeds. Repeat at 5 day spray intervals. OR Use copper sprays to reduce the rate of bacterial spread in the field. The combination of a copper fungicide plus maneb will increase the effectiveness of the application.	Use disease-free seed and/or transplants. Agri-strep cannot be applied to plants outside of the seedbed. Use disease-free seed and/or transplants. Avoid consecutive seasons with peppers or tomatoes in the same field. Avoid working in fields when plants are wet.
Phytophthora blight	Avoid water-logged root zones throughout the season. Use resistant varieties that are becoming available for commercial production. Check with seed sales representatives. Treat soil with Ridomil 2E at 4 to 8 pt. per acre (broadcast; use less for band application) before transplanting. Subsequent directed sprays may be needed. OR Maneb 80 at 2 to 3 lb. per acre at 7-10 day intervals. 7 day PHI.	Grow peppers in well drained fields. Planting on raised beds will increase soil drainage. Rotate infested fields with other crops for several years. Fungicides will not be effective if peppers are planted in poorly drained fields with a history of the disease. Water management is of primary importance for Phytophthora control. Kocide DF at 2 to 3 lb. per acre is labeled for use against bacterial spot, but may be effective against Phytophthora.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Dacthal 75WP	6 lb. on light-colored soils (less than 2% organic matter), 14 lb. on darker-colored soils in at least 50 gal. water per acre.	Apply 4-6 weeks after transplanting. Use 50-mesh or larger screens. Not effective on muck soils or other high organic soils.
Devrinol 50DP	2 lb. per acre on light colored soils (less than 2% organic matter), 4 lb. on other soils.	Incorporate Devrinol 1 to 2 in. before seeding or transplanting. After harvest or prior to planting succeeding crops a deep moldboard or disc plowing operation must be done. Do not seed alfalfa, small grains, sorghum, corn or lettuce for 12 months after using Devrinol.
Treflan 4E	1 pt. per acre on light-colored soils (less than 2% organic matter), 2 pt. on darker soils.	Apply to emerged weeds before planting crop. Wait 3 days before planting.
Command 4E	2 pt. per acre.	Must be incorporated. May cause some temporary bleaching of pepper foliage.
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Maximum of 4 to 5 pt. per acre per season. 20 day PHI.
STALE SEEDBED		
Gramoxone Extra 2.5E	2 to 3 pt. per acre plus 1 pt. nonionic surfactant per acre.	Apply before or after planting but before crop emerges. RUP.
Roundup (3lb./gal.)	2 to 3 qt. per acre.	Apply to emerged weeds before planting crop. Wait 3 days before planting.

* For specific weeds controlled by each herbicide, check table on page 23.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
European corn borer and Flea beetles	Apply one or more of the following as needed:	
	Orthene 75S at 1 lb. per acre.	Should also control aphids. 7 day PHI.
	OR	
	Ambush 2EC at 6.4 to 12.8 fl. oz., or 25WP at 6.4 to 12.8 oz. per acre Pounce 3.2EC at 4 to 8 fl. oz. per acre.	For Bell peppers only. Do not exceed 1.6 lb. AI per acre per season. Use higher rate for European corn borer. 3 day PHI.
	OR	
	Sevin 50WP at 4 lb. per acre for corn borer, or 2 lb. per acre for flea beetle.	0 day PHI.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Not for corn borers. Do not exceed 0.35 lb. AI per acre per season.
Aphids	Conserve natural enemies	Limiting the use of insecticides will conserve predators and parasites that help keep aphid populations under control.
	Orthene 75S at 0.6 to 1.3 lb. per acre.	7 day PHI.
	OR	
	Metasystox-R at 2 pt. per acre.	Do not apply more than twice per season. 0 day PHI.
	OR	
	Cygon 400 at 0.6 pt. per acre.	Use sufficient water to assure good coverage of plants. 0 day PHI.
	OR	
	Lannate 1.8L at 2 pt., or 90SP at 1/2 lb. per acre.	3 day PHI.
	OR	
	Thiodan 50WP at 1 to 2 lb. or 3EC at 0.6 to 1.3 qt. per acre.	Use sufficient water to assure good coverage of plants. 4 day PHI, 1 day if less than 1 lb. applied. Maximum of 2 applications per season.

Potato

Varieties	Season	Use	Scab Resistance	Appearance and Comments
Red Norland	Very Early	Market & Home	Good	Bright red, oblong, and smooth skinned, shallow eyes medium in number.
Redsen	Early			Attractive red, round, smooth, high specific gravity.
Cascade	Mid-season	Market & Home	Good	White, round shape.
Oneida	2nd Early	Market & Home	Good	White, flat-oblong.
Norchip	Mid Season	Chips & Market	Good	White, very high dry matter, ideal for baking and french fries; exceptional ability to produce white potato chips. Tubers sometimes rough.
Superior	Early	Chips & Market	Very Good	White, slight russet, oval; very popular.
Atlantic	Late	Chips & Market	Good	White, blocky-round, high yield; hollow heart, internal browning, high specific gravity.
Katahdin	Late	Market & Home	Fair	White, smooth, round, shallow-eyed.
Kennebec	Late	Chips	Fair	White, long, oval.
Red Pontiac	Late	Home garden	Fair	Red, round, very high yield, low specific gravity, good boiling, mashing type.
Russet Norkotah	Early	Market and home	Fair	Very good appearance, good baking quality with fair specific gravity.
For Trial Only:				
Conestoga	Early			A white type with good shelf life, shape, and baking quality.
Somerset	Mid-season			Blocky shape. Very good appearance, high specific gravity, chips well. White.
Yukon gold	Early	Local market and home		Yellow flesh, good size.

Spacing

Rows: 34 to 36 in. apart. Seed pieces: 9 to 11 in. apart in row, depending on variety and intended use. Seed: 16 to 18 100 lb. bags per acre. Seed piece should be 1.5 to 2 oz. Using B-size certified seed will save cutting labor and reduce tuber-borne diseases.

Fertilizing

Application Method	N	P_2O_5	K_2O
	(lb/acre)		
Broadcast and plow down	0	0	240
Banded at planting	24	96	0
Preplant or Sidedress shortly after emergence:			
Mineral soil	120	0	0
Organic soil	45	0	0

Vine Killing Product	Treatment	Comments
Evik	1.5 to 2.5 lb. per acre	Apply 10 to 14 days before harvest of summer potatoes only. Wait at least 3 weeks before planting cover crops because of possible injury. Do not apply after September 1 to avoid injury to sensitive crops.

VINE KILLING PRODUCT	TREATMENT	COMMENTS
Gramoxone Extra (2.5 E)	Apply 13 to 24 fl. oz. per acre in 50 to 100 gal. of water plus 8 to 32 fl. oz. of a nonionic spreader (such as X-77 or AG-98) per 100 gal. of water.	Begin application when leaves begin to turn yellow. Immature potato foliage and drought stressed potato foliage are tolerant to this product. This product cannot be used to desiccate potato vines when potatoes are to be stored or used for seed. Make no more than 2 applications with 5 days between applications. 2 day PHI. Read the label for complete instructions. RUP.
Diquat	Apply 1 pt. per acre in 20 to 100 gal. of water plus 8 to 16 fl. oz. of a nonionic spreader (such as X-77 or AG-98 per 100 gal. of water.	A second application can be made if necessary. Allow at least 5 days between applications. Apply at least 7 days before harvest.
DESI-CATE	Apply at 1.5 to 2 gal. per acre in 20 to 100 gal. of total spray. Use higher rate on muck soils.	Spray 10-14 days before harvest. The addition of 3 to 5 gal. per acre of fuel oil or 1 pt. of paraffin base herbicidal oil may increase speed and overall vine kill.

NOTE: the registration of all products containing dinoseb have been withdrawn and can no longer be used. This includes Dow General (DNBP) and Sinox General (DNBB) which were formerly used for vine killing.

CHEMICAL SPROUT CONTROL

Use maleic hydrazide (MH-30) according to label directions one week after blossoms fall. For varieties and conditions where flowering does not occur, apply 4 to 6 weeks before potatoes are mature and ready for harvest. Make only one application. Apply when no rain is expected for 24 hrs. Potatoes treated with MH cannot be used for seed since sprouting will be inhibited. Follow label directions.

NOTE: There have been important label changes in the use of maleic hydrazide (MH). For many years Royal MH-30 and Royal MH-30 SG have been used on potatoes to inhibit sprouting, control volunteer potatoes, and improve tuber quality. In 1984, several potato disorders such as tuber cracking, yield reduction, and reduced sizing were observed in the Northwest, in fields with circle pivot irrigation systems where an MH formulation had been applied. While the actual link between these disorders and use of MH is still unclear, Uniroyal no longer recommends MH on irrigated potatoes, and use on any potatoes (even without irrigation) is now listed at the user's risk.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Blackleg	Plant cut seed that has been stored under conditions for rapid healing of cut surfaces and treated with a labeled potato seed treatment.	Plant whole seed where possible.

DISEASES CONTROLLED	CONTROL METHOD	COMMENTS
Early blight	Bravo 720 at 0.75 to 1.5 pt. per acre. 0 day PHI. OR Bravo 90DG at 1 to 1.25 lb. per acre. 0-day PHI. OR Rovral 50W at 2 lb. per acre. 0 day PHI. Use a 7-10 day spray interval. Up to 4 applications per season. OR mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or Penncozeb at 2-3 lb. per acre. 5 day PHI.	Apply protective fungicides at 7 day spray intervals beginning at or before plants start to flower. With Bravo the low rate may be applied before vines close, then at increased rate after vine closure. Avoid droughty, wet, or compacted soils and other conditions (such as insufficient nitrogen) that might add undue stress to the crop and increase the susceptibility to early blight. Manex II is an alternative mancozeb fungicide for those who prefer the flowable formulation.
Fusarium dry rot	Mertect 340-F (2.5 pt. per 100 gal.). Treat potatoes as they go into storage.	The product should be applied uniformly as a fine mist. Avoid bruising at harvest. Cure potatoes in storage at 60°F before lowering temperature. Provide adequate ventilation.
Late blight	Destroy all potato cull piles. Ridomil/Bravo 81W at 1.5 to 2 lb. per acre. Use a 14 day spray interval. OR Bravo 720 at 1 to 1.5 pt. Use a 7-10 day spray interval. OR Bravo 90DG at 0.87 to 1.25 lb. per acre. Use a 7-10 day spray interval. OR mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or Penncozeb at 2 to 3 lb. per acre. 5 day PHI.	Apply when plants are 8 to 12 in. tall. Apply Ridomil at the first substantiated report of late blight in the area. 0 day PHI. Shorten Bravo spray interval during cool, wet weather. Manex II is an alternative mancozeb fungicide for those who prefer the flowable formulation.
Rhizoctonia canker	Avoid heavily infested fields and plant uncontaminated seed.	
Scab	Plant resistant varieties. Follow 3-4 year rotation schedule.	Maintain high moisture levels (near field capacity) during tuber set and enlargement. Do not apply manure or other organic matter immediately before planting. Avoid excessive liming and maintain acid soil pH.
Verticillium wilt	Employ at least a 2 year rotation with small grains to manage fungus populations in the soil.	Good weed control also is important in reducing pathogen populations.

DISEASES CONTROLLED	CONTROL METHOD	COMMENTS
Virus diseases and purple-top wilt (Aster yellows)	Plant only certified seed. Control aphids and leafhoppers with insecticides.	Practice clean cultivation. Rogue first infected plants, including tubers.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Dacthal 75WP	3 to 8 lb. on light-colored soils (less than 2% organic matter); 14 lb. on darker soils in at least 50 gal. of water per acre.	Apply immediately after planting or drag off. Use 50-mesh or larger screens. Not effective on muck soil.
Dual 8E	2 to 3 pt. per acre. Apply after planting and drag-off before crop or weeds emerge.	Dual might delay maturity and/or reduce yield of Superior and other early maturing potato varieties if cold wet soil conditions occur after treatment. Dual can be tank-mixed with Lorox, and Lexone or Sencor. See label. 40 day PHI.
Eptam 7E	2.3 to 3.5 qt. per acre. Granular material may be used.	Apply to soil surface before planting and immediately incorporate by double discing. Results are variable on muck soils. On muck soils, supplement with Lorox or Sencor/ Lexone applied just before crop emergence and after drag-off. The superior variety may be sensitive.
Eptam 10G	30 to 40 lb. per acre at lay-by.	Effective in suppressing nutsedge.
Lexone 4L or Sencor 4F	1 pt. per acre on light-colored soils (2% or more organic matter); 2 pt. per acre on dark-colored mineral soils and muck.	Apply just before crop emergence. Do not apply before drag-off.
Linex or Lorox 50DF	1.5 lb. per acre on light-colored soils (1 to 2% organic matter); 4 lb. per acre on dark-colored mineral soils and muck.	Apply just before crop emergence. Do not apply before drag-off. Do not use on soils with less than 1% organic matter. Apply when weeds are less than 2 inches tall.
Treflan 4E	1 to 2 pt. per acre.	Apply after planting and incorporate uniformly.
Prowl 4E	1.5 to 3.0 pt. per acre.	Apply soon after planting. Incorporate lightly. Do not use on muck soils. Follow with a delayed preemergence application of Lorox or Sencor/Lexone.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
POSTEMERGENCE		
Lexone 4L or Sencor 4F	1 pt. per acre.	Apply postemergence over the top of the potatoes. Avoid spraying during the 12 to 15 in. stage of growth to avoid injury. Do not apply within 3 days after a period of cool, wet or cloudy weather, or crop injury may occur. Do not use on early maturing or red skin varieties within 1 day of other pesticides, or more than 1 lb. AI per acre per year. May cause injury to sensitive crops the following year. 60 day PHI.
Poast 1.5E	1 to 1.5 pt. per acre plus 1 pt. nonionic surfactant.	Apply to actively growing grass. Maximimum of 5 pt. per acre per season. 20 day PHI.
STALE SEEDBED		
Gramoxone Extra 2.5E	1.5 pt. plus 1 pt. nonionic surfactant.	Apply before or after planting but before crop emerges. RUP.
Roundup (3 lb./gal.)	2 to 3 qt. per acre.	Apply to emerged weeds before planting in spring or after harvest in fall. Check label for specific weeds controlled and for recommended rates.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Flea beetles, Colorado potato beetle, leafhoppers	Populations of Colorado potato beetles are exhibiting resistance to many insecticides in some areas of the Midwest. If a previously effective insecticide is no longer effective, consider switching to another chemical class (pyrethroids, carbamates, organophosphates, cyclodienes, or *Bacillus thuringensis*).	
	Crop Rotation	Planting fields as far as possible from last year's potato fields will reduce potato beetle damage.
	Cultural Control	The use of straw mulch reduces potato beetle damage.
	Scouting	Regular (weekly) scouting of fields will allow you to determine the necessity for, and improve the timing of, insecticide treatments.
	Vydate 2L at 1 to 2 gal. per acre.	Apply in minimum of 200 gal. of water per acre in seed furrow during planting.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Flea beetles, Colorado potato beetle, leafhoppers (cont.)	Thimet 20G at 11.3 oz. per 1000 linear feet of row for any row spacing (minimum 32 in. spacing) in light or sandy soils; 17.3 oz. per 1000 feet of row in heavy or clay soils.	Apply as a band application on each side of row and beneath the soil surface, or in the seed furrow. Also controls early season aphid and leafhopper infestations. 90 day PHI.
	OR	
	Di-Syston 15G at 15 to 23 oz. per 1000 linear feet of row.	For potato leafhopper control early in the season. 75 day PHI.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not exceed 0.35 lb. AI per acre per season. Do not graze livestock on treated vines. 7 day PHI.
	OR	
	Ambush 2 EC at 3.2 to 12.8 fl. oz., or 25WP at 3.2 to 12.8 fl. oz. per acre.	Apply no more than 2.4 lb. AI per acre per season. Also for tarnished plant bug and cutworms. 7 day PHI.
	OR	
	Pounce 3.2EC at 4 to 8 fl. oz., or 25WP at 6.4 to 12.6 oz. per acre.	Apply no more than 2.4 lb. AI per acre per season. 7 day PHI.
	Vydate 2 at 1 to 4 pt. per acre.	For Colorado potato beetle. In sufficient water (minimum 4 gal. by air) to obtain uniform coverage. 7 day PHI.
	OR	
	Furadan 4F at 1 to 2 pt. per acre.	Do not make more than 8 applications per season. 14 day PHI.
	OR	
	Monitor 4EC at 1.5 to 2 pt. per acre.	Should also control cutworms and aphids. 14 day PHI.
	OR	
	Sevin 50WP at 2 lb. per acre.	Use may cause buildup of aphids and require additional chemical control. 0 day PHI.
	OR	
	Thiodan 50WP at 1 lb. or 3EC at 0.67 to 1.33 qt. per acre.	Do not exceed 6 applications or 3 lb. AI per acre per season. 1 day PHI.
	OR	
	Guthion 2S at 2 to 3 pt., or 50WP at 0.75 lb. per acre.	Do not make more than 3 applications per season. Allow at least 7 days between applications. 7 day PHI.
	OR	
	M-One at 1.5 to 2.5 qt. per acre, or Trident II at 1.5 to 3.0 qt. per acre, or M-Trak at 1.5 to 4.0 qt. per acre, or Novodor at 1.0 to 4.0 qt. per acre.	*Bacillus thuringiensis* based insecticides. For control of Colorado potato beetles only. Only controls small larvae. Other materials should be used to control adults and large larvae. 0 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Aphids	Conserve natural enemies.	Limiting the use of insecticides other than *Bacillus thuringiensis* products will conserve predators and parasites that help keep aphid populations under control.
	Cygon 400 at 0.5 to 1 pt. per acre. OR	Repeat applications as necessary. Controls leafhoppers. 0 day PHI.
	Lannate 1.8L at 2 pt. per acre.	6 day PHI.
Cutworms	Sevin 5B at 40 lb. per acre. OR	0 day PHI.
	Monitor 4EC at 2 pt. per acre.	Will also control aphids. 14 day PHI.
Wireworms	Site selection	Wireworms are most likely to be a problem in fields recently planted to sod or pasture, or in fields that have had a grassy weed problem.
	Sampling	Check for the presence of wireworms by burying a potato 6 in. deep in 5 locations per field prior to planting. Mark the spots with a flag. Dig the potatoes and inspect for wireworms 7 days later.
	Apply one of the following before planting or at time of planting:	
	Dyfonate II 10G at 40 lb. per acre. OR	Broadcast and work into top 2 to 3 in. of soil.
	Thimet 20G at 11.3 oz. per 1000 linear ft. of row for any row spacing (minimum 32 in. spacing) in light or sandy soils; 17.3 oz. per 1000 feet of row in heavy or clay soils.	Apply as a band application on each side of row and beneath the soil surface, or in the seed furrow. Also controls early season aphid and leafhopper infestations. 90 day PHI.

Rhubarb

Varieties

McDonald, Sutton, Valentine (produces fewer seed stalks than McDonald) – all red-fleshed varieties.

Planting and Spacing

Crowns: Use only young, healthy crowns having preferably 2 or 3 buds. Rows: 5 to 6 ft. apart. Set crowns in rows 3 ft. apart in shallow furrows so crowns will be 2 in. below surface.

Age for Harvesting

Harvest no longer than 4 weeks, beginning with the third season of growth. Harvest for about 8 to 10 weeks after the third season. Do not remove more than 2/3 of the developed stalks from any plant at one time.

Bolting (Seed Stalk Formation)

Infertile soil, extreme heat or cold, drought or long days that expose plants to too much light may cause bolting. Old plants bolt more. Valentine is more sensitive than McDonald, Ruby and most green-stalked varieties.

Fertilizing

Broadcast before beds are worked in the spring 75:75:75 (lb. per acre) $N:P_2O_5:K_2O$. Topdress with 50 lb. N.

DISEASES Controlled	Treatment	Comments
Ascochyta leaf spot	Fertilize in fall for growth in the spring.	Remove older, yellowed leaves or leaves with lesions in the fall.
Crown rot	Use disease-free plants.	Plant only on well-drained soil.

Herbicide*	Treatment**	Comments
PREEMERGENCE		
All weeds	Before spring growth, harrow bed thoroughly but carefully to avoid injuring the crowns. During growing season, cultivate row middles and hand hoe to keep the planting clean.	Mix in fertilizer with soil surface. Following first light freezes in fall, mulch with 3 to 4 in. of strawy manure and around plants, but not on crowns. If added mulch is needed next spring apply before hot, dry weather. Add more during summer if needed to control weeds and retain moisture.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Maximum of 3 pt. per acre per year. **ILLINOIS ONLY.**
STALE SEEDBED		
Gramoxone Extra 2.5E	2 to 3 pt. per acre, plus 1 pt. nonionic surfactant per acre.	For use on dormant rhubarb. Use higher rates for heavy weed infestation. Do not exceed 2 sprays per season. RUP.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Common stalk borer, Rhubarb curculio	There are no registered insecticides that will give adequate control.	Control by cultivating field and margins. Remove curly dock, the normal host of rhubarb curculio.
Cutworms, European corn borer	Pounce 3.2EC at 4 to 8 fl. oz. or Pounce 25W at 6.4 to 12.8 oz. per acre. OR Ambush 2EC at 6.4 to 12.8 fl.oz. or Ambush 25WP at 6.4 to 12.8 oz. per acre.	Apply every 3-5 days or as needed in sufficient water to obtain full coverage of foliage. 1 day PHI. Do not apply more than 2 lb. active ingredient per acre per season.

ROOT CROPS

Beet, Carrot, Parsnip, Radish and Turnip

Varieties

Beets: Ruby Queen, Crosby Greentop, Mono-King Explorer.
Carrots: GoldPak (for market); Red Cored Chantenay and Royal Chantenay (for canning).
For Trial Only: Apache, Sunex 3209, and Vita Sweet 711.
Parsnips: Harris' Model.
Radishes: Cherry Belle, Comet, Red Prince.
Turnips: Purple Top White Globe, Seven Top (greens).

Spacing

Beets: Rows: 18 to 24 in. apart. Seed: 8 to 10 lb. per acre for bunching.
Carrots: Rows: 18 to 24 in. apart. Seed: 2 to 4 lb. per acre.
Parsnips: Rows: 18 to 24 in. apart. Seed: 2 to 3 lb. per acre.
Radishes: Rows: 15 in. apart. Plant 12 to 15 per foot of row. Seed: 10 to 15 lb. per acre.
Turnips: Rows: 14 to 18 in. apart. Plant 2 to 3 in. apart in row. Seed: 1 to 2 lb. per acre.

Fertilizing

Application Method	N	P_2O_5	K_2O
Beets, Carrots, Parsnips:		(lb/acre)	
Broadcast and plow down	100	100	100
Radishes and Turnips:			
Broadcast	25	100	100

Include borax when treating sandy soils, light-colored silt and clay loams, and alkaline dark-colored soils. It may be omitted from acid dark-colored soils. Apply at 40 to 50 lb. per acre either alone or mixed with broadcast fertilizer. Borax should not come in contact with seed, but may be applied at 20 lb. per acre with fertilizer banded to the side of seed. On muck soil with a pH 6.0, add 2% manganese in the fertilizer.

DISEASES Controlled	Treatment	Comments
Alternaria leaf blight and Cercospora leaf blight	3-4 year crop rotation. Bravo 720 at 1.5 to 2 pt. per acre **(For use on carrots and parsnip only).** OR Rovral 50W at 1 to 2 lb. per acre. 0 day PHI. Apply on 7-14 day interval **(For use on carrots only).**	Start applying protective fungicides at the first sign of disease. 10 day PHI for Bravo on parsnip, and a maximum of 4 applications per season.
White mold **(carrot and parsnip only)**	3-4 year crop rotation.	Avoid including beans, cucurbits, celery, and late cabbage in the rotation.
Aster yellows	Use an insecticide to control leafhoppers that transmit the disease.	Excellent early season leafhopper control is essential. Control must occur before leafhoppers feed.

Herbicide*	Treatment**	Comments
PREEMERGENCE		
Beets:		
Ro-neet 6E	2 to 3 qt. per acre	Apply before planting, and incorporate immediately by double discing or other method.
Pyramin 4.2F	3 to 3.5 qt. per acre.	Apply after planting. Rainfall or irrigation necessary for activation.
Carrots:		
Treflan 4E	1 to 2 pt. per acre.	Mineral soil only. Apply before planting and incorporate 2-3 inches soon after spraying. Use low rates on sandy soils.
Horseradish:		
Dacthal 75WP	6 to 8 lb. on light-colored soils (less than 2% organic matter), 14 lb. on other soils.	Apply uniformly at planting time.
Goal 1.6E	1.25 to 2.5 pt. per acre.	Apply after planting prior to crop emergence.
Turnips:		
Dacthal 75WP	8 lb. on light-colored soils (less than 2% organic matter), 11 lb. on darker soils in at least 50 gal. water per acre.	Apply immediately after seeding. Use 50-mesh or larger screens. Not effective on muck and other high organic soils.
POSTEMERGENCE		
Beets:		
Antor 4E	2 to 6 qt. per acre (2 to 3 qt. on coarse, 3 to 4 qt. on medium, 4 to 6 qt. on fine textured soils).	Apply after planting but before weed or crop germination. Apply 0.5 in. of irrigation or rainfall for activation, can be tank mixed with pyramin. Processing beets only.
Spin-aid 1.3E	3 to 6 pt. per acre in 11 to 22 gal. of water.	Apply to red beets with 4 true leaves. Injury may occur if application preceeds the 4 leaf crop development stage. Do not apply if beets are stressed. Check label for precautions. Does not control pigweed. 60 day PHI.
Pyramin 4.2FL	3.5 qt. per acre plus 1 qt. COC per acre.	Timing is very important. Treat when beets have 2 expanded leaves and weeds have 2 to 4 leaves.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
POSTEMERGENCE:		
Carrots:		
Sencor 4F	0.5 pt. per acre.	Broadcast when carrots have 5 to 6 leaves. Do not apply during cool cloudy weather, or when temperature is above 85° F. Do not mix with other chemicals. Do not apply more than 1 oz. per season if carrots are rotated with onions. 60 day PHI.
Linex or Lorox 50DF	1 to 2 lb. per acre.	Apply premergence or when crop is at least 3 in. tall. Do not apply if temperatures exceed 85°F.
Fusilade 1E	1.5 pt. per acre. Plus 1 pt. nonionic surfactant.	Apply to actively growing grass. Best control if applied at less than 30 gal per acre. Check label for specific grasses controlled.
Carrots and Parsnips:		
Stoddard Solvent	60 to 80 gal. per acre undiluted.	Apply after carrots have 2 true leaves. Do not spray within 6 weeks of harvest. Do not apply within 14 days of other herbicides.
Parsnips:		
Linex or Lorox 50DF	2 lb. per acre on light colored soils (less than 2% organic matter), 3 lb. on darker colored soils.	Apply before parsnips emerge and again after they are 4 in. tall. Apply when weeds are less than 2 in. tall. Do not apply when temperatures exceed 85°F or pressure greater than 40 psi.
STALE SEEDBED		
Beets, Carrots, Parsnips, and Radishes:		
Gramoxone Extra 2.5E	2 to 3 qt. per acre plus 1 pt. nonionic surfactant per acre.	Apply before or after planting, but before crop emerges. RUP.
Roundup (3 lb./gal.)	2 to 3 qt. per acre.	Apply to emerged weeds before planting in spring or after harvest in fall. Check label for specific weeds controlled and rate.
Horseradish:		
Roundup (3 lb./gal.)	1.5 to 3.0 pt. per acre	Apply to emerged weeds before planting in the spring.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Carrots: Leafhoppers	Beginning when plants are 3 in. tall, use one of the following:	
	Methoxychlor 2EC at 2 to 4.5 qt. per acre.	14 day PHI.
	OR	
	Sevin 50WP at 2 lb. per acre.	Both field margins and fields should be treated for good control of these plant disease transmitters.
	OR	0 day PHI.
	Cythion or Malathion 57EC at 2.5 pt. per acre.	7 day PHI.
Cutworms	Dylox or Proxol 80SP at 10 to 20 oz. per acre.	Do not use tops for food or feed. 28 day PHI.
Aphids	Diazinon 50WP at 1 lb. per acre.	10 day PHI.
	OR	
	Malathion 57EC at 1.5 pt. per acre.	7 day PHI.
Beets: Variegated cutworm	Apply one of the following as needed:	
	Dylox or Proxol 80SP at 1.25 lb. per acre.	Do not eat tops. 28 day PHI.
	OR	
	Lannate 1.8L at 2 pt., or 90SP at 0.5 to 1 lb. per acre.	Harvest restrictions: roots–0 days; tops–14 days. Apply in sufficient water to obtain thorough coverage.
Aphids	Diazinon 50WP at 1 lb. per acre.	14 day PHI.
Radishes: Aphids, flea beetles	Use one of the following as needed:	
	Asana XL 0.66 EC at 5.8 to 9.6 oz. per acre.	Do not apply more than 0.1 lb. AI per acre per season.
	OR	
	Diazinon AG500 at 1 pt. per acre.	10 day PHI.
	OR	
	Malathion 57EC at 1 qt. per acre.	7 day PHI.
	OR	
	Sevin 50WP at 2 lb. per acre.	Flea beetles only. Will not control aphids. 3 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Radishes, continued: Root maggots	Apply one of the following as a furrow application at planting:	
	Lorsban 4E at 1 oz. per 1000 feet of row, or 15G at 3.3 oz. per 1000 feet of row.	Apply 4E as a water-based (minimum 40 gal. water) drench, or the 15G in seed furrow with the seed at planting time. Do not exceed 5.5 pt. of 4E or 18.3 lb. of 15G per acre. Make only one application per season.
	OR	
	Diazinon 14G at 2.5 to 2.8 oz. per 1000 linear feet of row.	
Turnips: Root maggots	As a furrow application at time of planting, same as for radishes as listed above.	
	Diazinon AG500 at 1 pt. per acre.	Apply as a drench spray over the row 30 days following planting. 10 day PHI. Will also help manage flea beetles.
Aphids, flea beetles	Mevinphos 400 at 0.25 to 0.5 pt. per acre.	*HIGHLY POISONOUS!* Follow all precautions. Beets, carrots, and turnips only. 3 day PHI for beets and turnips. 2 day PHI for carrots.
	OR	
	Cygon 400 at 0.5 pt. per acre.	May not control flea beetles. 14 day PHI.
	OR	
	Metasystox-R 2EC at 1.5 to 2 pt. per acre.	Do not apply more than 2 times per season. 7 day PHI, 21 day for turnip greens.
	OR	
	Sevin 50WP at 2 lb. per acre.	Flea beetles only. 3 day PHI. 14 days for turnip tops to be used for food or feed. Will not control aphids.
	OR	
	Diazinon AG500 at 1 pt. per acre.	10 day PHI.
	OR	
	Malathion 57EC at 1 qt. per acre.	3 day PHI.
	OR	
	Ambush 2E at 3.2 to 6.4 fl. oz. per acre, or 25W at 3.2 to 6.4 oz. per acre.	1 day PHI. Illinois and Indiana only.

SALAD AND GREEN CROPS

Spinach, Lettuce, Mustard, Collard, Endive, Parsley, Herbs, and Kale

Varieties

Spinach:	Bloomsdale Long Standing (spring), Early Hybrid No. 7 (fall), Early Hybrid No. 10 (fall), Old Dominion (fall), Virginia Savoy (fall).
Leaf Lettuce:	Black Seeded Simpson, Grand Rapids Strains, Domineer.
Bibb Lettuce:	Bibb, Buttercrunch.
Head Lettuce:	Minetto, Ithaca, Fairton, Romaine, Cos.
Endive:	Full Heart Batavian, Green Curled Ruffoc.
Mustard:	Southern Giant.
Collard:	Georgia, Vates. For blue-green leaves: Blue Max and Hi Crop.
Kale:	Blue Armor, Blue Knight.
Parsley:	Curly leaf: Moss Curled, Dark Moss Curled, Perfection. Flat leaf: Plain. Hamburg Parsley: has enlarged edible root marketed as a fresh product.
Fennel:	Marketed for its foliage as anise and for its edible leaf base as Florence or finocchio fennel. Plant has a strong licorice flavor and aroma.
Sweet Basil:	Green foliage: Sweet basil, Mammoth, Large leaf; Small leaf: Lemon and Piccolo; Purple foliage: Dark Opal, Opal.

Spacing and Seeding

Spinach:	Rows: 12 to 18 in. apart. Plants 4 to 6 per foot of row. Seed: 12 to 20 lb. per acre.
Lettuce, Endive & Mustard:	Rows: 12 to 15 in. apart. Plants 10 to 16 in. apart in row. Seed: 1 to 2 lb. per acre.
Collard:	Rows: 36 to 42 in. apart. Plants 18 to 24 in. apart in row. Seed: 1 to 2 lb. per acre.
Sweet Basil:	Rows 15 to 36 in. apart. Plants 6 to 8 in. apart within rows.
Parsley:	Rows: 15 in. apart. Plants 4 to 8 in. apart in row. Seed: 30 lb. per acre.

Except for collard, these crops can have a common between-row spacing for convenience in cultivating.

Fertilizing

Broadcast and plow down 120:120:120 (lb. per acre) $N:P_2O_5:K_2O$, use 90-120 lb. N per acre for herbs.

DISEASES Controlled	Control Method	Comments
Spinach, Collard and Mustard Greens:		
Damping off	Plant only western grown, hot-water treated seed which has been treated with thiram or captan.	
	Apply Ridomil 2E at 4 to 8 pt. per acre preplant to control damping-off caused by *Pythium* spp. (Spinach only.)	Apply preplant to the soil surface in a 7 in. band over the row, and incorporate to a depth of 2 inches.
Downy mildew, white rust	Plant downy mildew resistant spinach varieties.	
	Apply Ridomil 2E at 4 to 8 pt. per acre pre-plant, and 1 pt. per acre after planting, (Spinach only).	Preplant soil application, with up to 2 additional soil applications after planting.
	OR	
	Apply Aliette at 2-3 lb. per acre.	Apply when conditions are favorable for disease and continue on a 7-21 day interval. Do not tank mix with copper fungicides. 3 day PHI.
	OR	
	Apply basic copper sulfate at 3 pt. per acre.	Apply fungicides at 10 day intervals beginning at the first sign of disease.

Spinach, Lettuce, Mustard, Collard, Endive, Parsley Disease Control (cont.)

DISEASES Controlled	Control Method	Comments
Lettuce:		
Seed rot, damping off	Treat seed with captan or thiram.	
	Apply Ridomil 2E at 4 to 8 pt. per acre preplant (**head lettuce only**).	
Bottom rot and drop	Avoid wet fields with a history of disease, and apply one of the following fungicides:	
	Rovral 50W at 1.5 to 2 lb. per acre.	Apply at the 3-leaf stage (head lettuce only). Repeat application in 10 days. A third application may be necessary if disease-favorable conditions persist. 14 day PHI.
	OR	
	Ronilan 50W at 1 to 2 lb. per acre.	Apply 7-10 days after transplanting (head lettuce only). Repeat application in 14 days. A third application may be necessary if disease-favorable conditions persist. 28 day PHI.
	OR	
	Botran 75W at 5 lb. per acre.	Do not apply to leaf lettuce within 7 days of transplanting 14 day PHI.

Herbicide*	Treatment**	Comments
PREEMERGENCE		
Kale, Mustard, Collard, Spinach, Chickory, and Turnip Greens:		
Dacthal 75WP	8 lb. on light colored soils (less than 2% organic matter), 14 lb. on darker colored soils in at least 50 gal. water per acre.	Apply immediately after seeding. Use 50-mesh or larger screens. Not effective on muck or high organic soils.
Treflan 4E	1 pt. per acre on light colored soils (less than 2% organic matter), 1.5 pt. on darker colored soils.	Apply before planting, and incorporate immediately into soil by double discing, or with other equipment, to give thorough mixing 3 to 4 in. deep. Not effective on muck and other high organic soils.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE (cont.):		
Lettuce, Endive:		
Kerb 50WP	2 lb. on light colored soils to 4 lb. per acre on dark colored soils with 4% or less organic matter.	Apply before or after seeding of lettuce and before weeds germinate. Must be incorporated or irrigated into soil. Can be applied postemergence to the lettuce.
Lettuce:		
Balan 1.5LC	3 to 4 qt. per acre.	Apply before planting and incorporate 2-3 in. into soil immediately.
Prefar 4E	5 to 6 qt. per acre.	Can be applied to head or leaf lettuce. Must be incorporated.
POSTEMERGENCE		
Lettuce, Spinach, Chicory, Kale, Mustard, Turnip Greens, Collards:		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. 15 day PHI lettuce and spinach, 30 day PHI mustard, collards, turnip greens.
Spinach only:		
Antor 4E	2 to 4 qt. per acre.	Apply preplant incorporated or preemergent to crop. Apply 0.5 in. of irrigation or rainfall for activation if applied preemergent.
Spin-Aid 1.3E	3 to 6 pt. per acre in 11 to 22 gal. of water for processing and seed lettuce only.	Apply to spinach past the 4 true leaf stage. Injury may occur if application preceeds the 4 true leaf stage of spinach. Do not apply if spinach is under stress. Check label for weed control precautions. Does not control pigweed. 40 day PHI.
STALE SEEDBED		
All crops:		
Roundup (3 lb./gal.)	2 to 3 qt. per acre.	Apply to emerged weeds before planting in spring or after harvest in fall. Check label for specified weeds controlled and rate.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
STALE SEEDBED (cont.)		
Lettuce, Spinach, and Collards:		
Gramoxone Extra 2.5E	2 to 3 pt. per acre plus 1 pt. nonionic surfactant per acre.	Apply before of after seeding but before crop emerges. RUP.

* For specific weeds controlled by each herbicide, check table on page 23.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Aphids, leafminers, mites	Use one of the following as needed:	
	Metasystox-R 2S at 1.5 to 2 pt. per acre.	Head lettuce only. Do not make more than 3 applications per season. 21 day PHI.
	OR	
	Cygon 400 at 0.5 pt. per acre.	14 day PHI for collard, endive, mustard greens, Swiss chard, spinach, turnip greens, and leaf lettuce; 7 day PHI for head lettuce. Do not use on parsley.
	OR	
	Mevinphos 400 at 0.25 to 0.5 pt. per acre.	*HIGHLY POISONOUS!* Follow all precautions. 3 day PHI for mustard. 4 day PHI for head lettuce and spinach. 10 day PHI for leaf lettuce. 7 day PHI for collard and kale. Do not use on endive or parsley.
	OR	
	Dibrom 8E at 1 pt. per acre.	4 day PHI for collard or kale. 1 day PHI for spinach and turnip greens. Do not use on lettuce, mustard, endive, or parsley.
Flea beetles, leafhoppers	Use one of the following as needed:	Treat field margins and fields for leafhopper control.
	Malathion 57EC at 1.5 pt. per acre.	14 day PHI for leaf lettuce; 7 day PHI for head lettuce, endive, collard, mustard greens, and spinach; 21 day PHI for parsley.
	OR	
	Sevin 50WP at 2 lb., or 80SP at 1.25 lb. per acre.	3 day PHI for head lettuce; 14 day PHI for endive, collard, leaf lettuce, mustard, parsley, and spinach.

INSECTS CONTROLLED	TREATMENT	COMMENT
Caterpillars, loopers	*Bacillus thuringiensus* (MVP, Javelin, Dipel, Thuricide, Biobit).	Follow label instructions for rates and use. 0 day PHI.
	OR	
	Lannate 90 SP at 0.5-1 lb. per acre or 1.8L at 2 to 4 pt. per acre.	7 day PHI for lettuce at 0.25 to 0.5 lb. rate, or 10 day PHI for 1 lb. rate; 7 day PHI for spinach; 10 day PHI for collard and Chinese cabbage. Should control aphids.
	OR	
	Cymbush 3E at 1.07 to 4.27 fl. oz. per acre.	Do not apply more than 0.6 lb. AI per acre per season. Head lettuce only. 5 day PHI.
	OR	
	Larvin 3.2 AF at 16 to 30 fl. oz. per acre. Not for mustard or collard.	Do not exceed 60 fl. oz. per acre per season. 14 day PHI.
	OR	
	Ambush 2EC at 3.2 to 12.8 fl. oz., or 25WP at 6.4 to 12.8 oz. per acre, or Pounce 3.2EC at 2 to 8 fl. oz., or 25WP at 6.4 to 12.8 oz. per acre.	Do not apply more than 2 lb. AI per acre per season. 1 day PHI. Do not graze treated acres or feed crop refuse to livestock. **Illinois only.**

SNAP BEAN, DRY BEAN AND LIMA BEAN

Snap Bean Varieties	Use	Pod Color	Seed Color	Comments
Bush Blue Lake 92	market	dark green	white	early
Bush Blue Lake 274	market	dark green	white	excellent quality
Bronco	market	dark green	white	excellent qlty., relatively tolerant to cold soils.
Eagle	market	dark green	white	ships well, also use for freezing and canning
Win	market	dark green	white	similar to Eagle
Flo	market	med. green	white	excellent quality
Provider	market	med. green	purple	early market
Kinghorn Wax	market	yellow	white	excellent quality, also use for canning

For Trial Only: Strike (fresh market, med. green pod color, excellent flavor), Atlantic, Hystyle, Mustang, and Laureat.

Lima Bean Varieties	Use	Seed Color	Comments
Henderson Bush	market & home	white	Bush, very early, small seed, high yield
Fordhook 242	market & home	white	Bush, midseason, med. size, variable yield
Bridgeton	processing	greenish	Bush, late, medium size
King of the Garden	home garden	greenish-white	Pole, midseason to late, large seed

SPACING AND SEEDING

Row: 18 to 30 ft. apart; 5 to 7 seeds per foot of row. Seed: 70 to 100 lb. per acre.

IRRIGATION

If soil is dry at planting time, irrigate to insure uniform seed germination. Snap beans must be irrigated in dry seasons, especially during blooming and pod development. They need 1 to 1.5 in. of water every 4-5 days.

FERTILIZING

Application Method	N	P_2O_5	K_2O
		(lb/acre)	
Broadcast and plow down	75	75	150
Band (placement 2"x2") at seeding	12	48	0

DISEASES CONTROLLED	TREATMENT	COMMENTS
Anthracnose, Rust	Follow 2-3 year crop rotation schedules.	
	Some rust resistant varieties are available.	Dade, Kentucky Wonder Rust Resistant.
	Apply Bravo 720 at 2 pt. per acre. Begin sprays at early bloom.	Repeat at 7-10 day intervals. 6 week harvest restriction. Do not feed treated plants to livestock.
	OR	
	Apply Maneb 80 at 1.5 to 2.0 lb. per acre. Begin sprays when plants are small. (Dry bean only).	Repeat at 5-7 day intervals. Do not apply within 30 days of harvest. Do not apply more than 9.6 lb. active ingredient per acre per season.
Bacterial blights	Plant only western grown, certified seed.	
	Follow 2 -3 year crop rotation schedules.	
	Treat seed with Agri-Strep 500 at 0.3 oz. per 100 lb. seed.	
	Field applications of fixed copper fungicides (e.g. Kocide or Champ) at 2 to 4 lb. per acre.	Repeat at 7-10 day intervals. Copper sprays will slow the spread of bacterial blights in the field. Do not use copper on fresh market lima bean.
White mold and Gray mold	Avoid wet fields with a history of white mold.	
	Benlate 50DF or Topsin-M at 1.5 to 2 lb. per acre. 14 day PHI for snap bean, 28 days for lima bean.	Apply fungicides when 0.25 to 0.5 of the plants show blossoms. Repeat at 7-10 day intervals for Benlate or Topsin-M. Repeat at full bloom for Rovral. Observe restrictions on feeding of forage.
	OR	
	Rovral at 1.5 to 2 lb. per acre.	
Seedling diseases and root rots	Plant only western grown certified seed in warm well-drained seed beds.	
	Treat seed with Apron 25WP plus captan or thiram.	Apron and Ridomil may be helpful for early season seedling diseases caused by Pythium.
	Apply Ridomil 2E at 2 to 4 pt. per treated acre at planting or Ridomil PC 11G at 0.75 lb. per 1000 ft. of row at planting.	Ridomil PC 11G or PCNB may be used to help control Rhizoctonia.
Soybean Cyst Nematode (SCN)	Rotate at least 2 to 3 years with corn, small grains, alfalfa, or other non-host crop.	Do not include soybeans in the rotation.
Mosaic Virus Diseases	Plant varieties with resistance to common mosaic, NY15 strain of common mosaic, and bean yellow mosaic.	Bush Blue Lake 274, Provider, Tendercrop, Cherokee, Goldcup

Herbicide*	Treatment**	Comments
PREEMERGENCE		
Dacthal 75WP	8 lb. on light soils (less than 1.5% organic matter); 14 lb. on darker soils in at least 50 gal. water per acre.	Apply immediately after planting. Use 50-mesh or larger screens. Not effective on muck soils and other high organic soils.
Dual 8E	1.5 to 3 pt. per acre. Apply preplant incorporated or preemergence.	Do not use on muck soils. Apply before or after seeding but before crop emergence.
Treflan 4E	1 pt. per acre on light colored soils (less than 2% organic matter), 1.5 pt. on darker-colored soils.	Apply before planting, and incorporate immediately by double discing or with other equipment for thorough mixing 3 to 4 in. deep. Not effective on muck soil and other high organic soils.
Eptam 7E	2 qt. per acre.	Apply preplant, and incorporate immediately into soil by double discing or with other equipment to give thorough mixing 3 to 4 in. deep.
Prowl 4E	1 to 3 pt. per acre.	Apply before planting, and incorporate 1 to 2 in. deep.
Pursuit 2E	3 fl. oz. per acre.	Use on lima bean and red kidney beans only.
Lasso 4E	2.5 to 3 qt. per acre.	Red kidney bean only. Apply preplant incorporated or preemergence.
POSTEMERGENCE		
Basagran 4E	1.5 to 2 pt.	Do not apply until first trifoliate leaf is fully expanded. Do not apply more than 2 qt. per acre per year.
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Maximum of 4.0 pt. per acre per season. 15 day PHI for succulent beans. 30 day PHI for dry beans.
STALE SEEDBED		
Gramoxone Extra 2.5E	2 to 3 pt. per acre plus 1 pt. nonionic surfactant per acre.	Apply before or after seeding but before crop emergence.
Roundup 3 lb./gal.	2 to 3 qt. per acre.	Apply to emerged weeds before planting in spring or after harvest in fall. Check label for specific weeds controlled and rate.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Seed corn maggot	Plant seed that has been treated with a product containing diazinon or a lindane-diazinon combination.	Flies are attracted to rotting organic material and freshly plowed soil. Plow sod or winter cover crop under early in the spring and thoroughly cover. Handle seeds carefully to prevent cracking.
	OR	
	Thimet 20G at 4.5 to 7 oz. per 1000 linear feet of any row spacing (minimum 30-in. spacing).	Apply granules in a band over the row at planting time. Do not place Thimet granules in direct contact with the seed. Do not feed bean foliage. 60 day PHI.
Mexican bean beetle, leafhoppers, bean leaf beetle, aphids	Use one of the following:	
	Di-Syston 15G at 6 to 12 oz. per 1000 feet row (for any row spacing), or 6.7 to 13.3 lb. per acre (30-inch row spacing).	Place granules on each side of seed furrow at planting. Do not apply directly on the seed or more than once per season. 60 day PHI. Do not use treated vines for feed.
	OR	
	Orthene 75S at 0.6 to 1.3 lb. per acre. Should control corn borer at high rate.	14 day PHI for snap and dry beans; 0 days for lima beans. Do not use treated vines as feed.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not exceed 0.2 lb. AI per acre per season. Do not feed or graze livestock on treated vines. 21 day PHI on dry beans. 3 day PHI on snap beans.
	OR	
	Sevin 50WP at 2 lb. per acre. Use 1 lb. per acre for Mexican bean beetle.	Will not control aphids. 0 day PHI.
	OR	
	Lannate 1.8L at 2 pt. per acre.	Do not feed hay to livestock for 7 days. Not for bean leaf beetle. 1 day PHI for succulent beans. 25 day PHI for dry beans.
	OR	
	Methoxychlor 2EC at 2 to 6 qts. per acre.	Not for use to control aphids. 3 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Mexican bean beetle, leafhoppers, bean leaf beetle, aphids (cont.)	Thiodan 50WP at 1 lb., or 3EC at 0.69 to 1.33 qt. per acre.	Apply before leaves curl. Do not apply more than 3 times per season. Do not feed treated threshings to livestock or allow to graze in treated fields. Do not use on lima bean. 3 day PHI.
	OR	
	Metasystox 2RS at 2 pt. per acre.	No more than 3 sprays per season. 21 day PHI. Do not graze or feed within 21 days of application. Should also control mites. Not for dry bean.
	OR	
	Cygon 400 at 0.5 to 1 pt. per acre.	Do not feed treated vines to livestock. Will control aphids and leafhoppers only. 0 day PHI.
	OR	
	Penncap-M at 2 pt. per acre	Succulent beans: 3 day PHI. Do not make more than 3 applications per season. Dry beans: 15 day PHI. Do not apply from 7 days before bloom through peak bloom.
European corn borer	Orthene 75S at 1.3 lb. per acre.	Repeat treatment at 7 day intervals as long as moth flight and oviposition continue or until beans are ready to be harvested. 14 day PHI. 0 day PHI for lima bean.
	OR	
	Penncap-M at 2 to 4 pt. per acre.	See above. 3 day PHI.
	OR	
	Lannate 1.8L at 4 pt. or 90SP at 1 lb. per acre.	3 day PHI. 25 day PHI for dry bean.
Corn Earworm	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not exceed 38.4 fl. oz. per acre per season. Do not feed vines to livestock. 3 day PHI.
	OR	
	Sevin 50WP at 3 lb. per acre.	0 day PHI
Mites	Kelthane MF at 0.75 to 1 pt. per acre.	Apply at first sign of mites. Repeat as necessary. Do not feed treated vines to meat or dairy animals. 7 day PHI.
	OR	
	Cygon 400 at 0.5 to 1 pt. per acre.	Do not feed to livestock. Do not apply during bloom. 0 day PHI.

Squash and Pumpkin

Varieties

Summer Squash: Zucchini Elite, Zucchini Hybrid, Seneca Butterbar Hybrid, Early Yellow Summer Crookneck.
Winter Squash: Buttercup, Hercules (Butternut type), Delicious, Hubbard Strains, Royal Acorn.
Pumpkin:
Small size: Small Sugar, Jack Be Little, Munchkin (decorative only), Little Boo (white), Mini-Jack.
Medium size: Spirit Hybrid, Jack O'Lantern, Funny Face, Autumn Gold.
Large size: Connecticut Field, Howden, Jackpot Hybrid, Wizard.
Very large size: Atlantic Giant, Big Moon, Big Max, Big Autumn, Prize Winner.
Hull-less or naked seed: Trick or Treat (medium size, can also be used as a Halloween type).

Spacing and Seeding

Bush Types: Rows: 4 to 6 ft. apart. Plants 18 to 24 in. apart in row. Seed: 4 to 6 lb. per acre.
Vining Types: Rows: 4 to 6 ft. apart. Plants 2 to 3 ft. apart in row. Seed: 2 to 3 lb. per acre.

Fertilizing

Broadcast and plow down 100:100:200 (lb. per acre) $N:P_2O_5:K_2O$.

DISEASES Controlled	Treatment	Comments
Anthracnose	Bravo 720 at 2 to 3 pt. per acre. OR Bravo 90DF at 1.5 to 2.5 lb. per acre. OR Benlate at 8 oz. per acre.	Apply protective fungicides at 7-14 day intervals, on squash or pumpkin fields that have a history of anthracnose. 0 day PHI.
Bacterial wilt	Use systemic and contact insecticides for cucumber beetle control.	Consult section on bacterial wilt control for cucumbers and melons.
Black rot	3-4 year crop rotation. Avoid fields with a history of black rot or gummy stem blight problems.	Rotate fields with other crops to prevent a rapid build-up of pathogen populations.
	Bravo 720 at 2 to 3 pt. per acre. OR Bravo 90DF at 1.5 to 2.5 lb. per acre. OR	7-14 day spray interval. 0 day PHI.
	mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or Penncozeb DF at 2 to 3 lb. per acre. 5 day PHI.	Manex II is an alternative mancozeb fungicide for those who prefer the flowable formulation.
Downy mildew	Bravo 720 at 2 to 3 pt. per acre. 7-10 day spray interval. 0 day PHI. OR Ridomil/Bravo 81 at 1.5 lb. per acre. 14 day spray interval. 0 day PHI. OR Fixed copper fungicides at 7-10 day intervals	Cucurbit downy mildew can appear in the Midwest as early as late August, but perhaps earlier in southern Missouri. One or two applications of a systemic fungicide may be economically feasible. Apply Ridomil only after downy mildew has been positively identified.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Powdery mildew	Bayleton at 2 to 4 oz. per acre. 14 day spray interval. OR Benlate at 8 oz. per acre. 10-14 day spray interval. OR Topsin 85WDG at 4 oz. per acre. 10-14 day spray interval.	Apply Bayleton beginning at first sign of disease. 0 day PHI. If using Benlate or Topsin, first application should be made within the first 2 weeks of August, second and third applications at 2 week intervals. 0 day PHI.
Phytophthora blight	Avoid fields with a history of the disease on cucurbits or peppers.	Turban squash is extremely susceptible.
	Apply protectant fungicides at 7-14 day intervals through September. Fungicides include:	Fungicides are needed to protect fruit.
	Bravo 720 at 2 to 3 pt. per acre. OR Bravo 90 DF at 1.5 to 2.5 lb. per acre.	Bravo fungicides have a 0 day PHI.
	OR	
	mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or Penncozeb DF at 2 TO 3 lb. per acre. 5 day PHI.	Manex II is an alternative mancozeb fungicide for those who prefer the flowable formulation.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Dacthal 75WP	8 lb. on light soils (less than 1.5% organic matter), 14 lb. on other soils.	Not effective on soils with greater than 5% organic matter. Use on summer and winter squash only. Apply to soil when plants are well established and have 4 to 5 true leaves.
Prefar 4E	4 qt. per acre on light-colored, sandy soils (less than 1% organic matter), 6 qt. on other soils.	Apply before seeding or transplanting and incorporate into soil by discing or with other equipment to give thorough mixing to a depth of 2 to 3 in. May be applied to the soil surface immediately after seeding in freshly worked soil if sprinkler-irrigated within 24 hours. Do not apply after transplanting.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
Command 4E	1.5 to 2 pt. per acre.	Pumpkins ONLY. Incorporate 2 to 3 in. before seeding. May cause some temporary bleaching of pumpkin plants.
Curbit 3EC	3 to 4 pt. per acre. Requires signing a waiver of liability before using.	Apply Curbit to the soil surface within 2 days after seeding of pumpkins, winter and summer squash. Do not incorporate Curbit prior to planting as crop loss will occur. See label for other restrictions. 24C label in Indiana and Illinois.
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Maximum of 3 pt. per acre per year. 14 day PHI.
STALE SEEDBED		
Gramoxone Extra 2.5E	2 to 3 pt. per acre plus 1 pt. nonionic sufactant per acre.	Apply before or after seeding, but before crop emerges. RUP.
Roundup (3 lb./gal.)	2 to 3 qt. per acre.	Apply to weeds before planting. Wait 3 days to plant.

* For specific weeds controlled by each herbicide, check table on page 23.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Cucumber beetles	Furadan 15G at 8 to 12 oz. per 1000 linear feet of row (13.3 lb. per acre based on 60-inch row spacing). NOTE: Furadan 4F *is not* registered for this use either by ground or aerial application.	Apply at planting - either direct seeding or at time of transplanting - in a furrow or in a band and incorporate into the top 3 inches of soil. Use for seedling protection against beetle attack as seedlings emerge from the soil and as transplants are becoming established in the field. Spray or dust transplants with another insecticide just before or after they are set in field to protect them until they uptake this systemic insecticide.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Cucumber beetles, squash vine borer, squash bug	Use one of the following for seedling protection during emergence, after transplanting, and/or protection of plants during the season when beetles are present:	
	Sevin 50WP at 2 lb. per acre.	For cucumber beetles, apply as soon as plants emerge, and repeat as needed. 0 day PHI.
	OR	
	Methoxychlor 3EC at 2 to 6 qts. per acre.	For cucumber beetles, apply as soon as plants emerge, and repeat as needed. 7 day PHI.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	3 day PHI. Do not exceed 0.25 lb. AI per acre per season.
	OR	
	Thiodan 50WP at 2 lb. per acre.	Also controls squash vine borer. 0 day PHI for squash, 1 day for pumpkin.
	OR	
	Dylox or Proxol 80SP at 1.25 lb. per acre.	For squash bug nymphs only. Pumpkins only. No more than 3 applications per season. 3 day PHI.
	OR	
	Pounce 3.2EC at 4 to 8 oz., or 25WP at 6.4 to 12.8 oz. per acre.	Apply in minimum of 4 gal. finished spray per acre by air or 20 gal. finished spray per acre by ground equipment. Do not apply more than 1.6 lb. AI per acre per season. 1 day PHI.
	OR	
	Ambush 2E at 12.8 fl. oz., or 25WP at 12.8 oz. per acre.	
	Lannate 1.8L at 2 to 4 pt. per acre.	Summer squash only. PHI: 2 pt. - 1 day, more than 2 pt.-3 days. Will also control aphids.
Aphids, leafhoppers	Use one of the following as needed:	
	Diazinon 50WP at 1 to 1.5 lb., or AG500 at 1 to 1.5 pt. per acre.	3 day PHI for winter squash, 7 days for summer squash. Do not use on pumpkin.
	Metasystox-R 2EC at 1.5 to 2 pt. per acre.	14 day PHI for pumpkin or winter squash, 1 day for summer squash. Do not apply more than once per season.
	Malathion 57EC at 2 pt. per acre.	3 day PHI for pumpkin, 1 day for squash. Do not use for leaf-hoppers.
Spider mites	Kelthane 35WP at 1 lb. per acre.	2 day PHI. Ground application only.

Sweet Corn

Fresh Mkt. Varieties	Approximate Days to Maturity Lafayette, IN	Ames, IA	Season	Ear Weight (lb.)	Kernel Color	Rows of Kernel	Plant Height (ft.)
Aztec	-	79	early	.57	yellow	14-16	6
Commanche	72	-	early	.60	yellow	14-16	5 1/2
Commander	86	-	main	.80	yellow	16-18	7 1/2
Dandy	84	-	main	.75	bicolor	16-18	7 1/2
Earliking	-	74	early	.54	yellow	12	5 1/2
Gold Cup	80	83	main	.70	yellow	14-16	6 1/2
Gold Winner	79	-	main	.70	yellow	14-16	6 1/2
Honeycomb	80	83	main	.70	yellow	14-16	6 1/2
NK 199	82	84	main	.80	yellow	16-18	7 1/2
Seneca Horizon	65	72	early	.60	yellow	14-16	5 1/2
Silver Queen	86	95	main	.75	white	16-18	7 1/2
Spring Gold	68	75	early	.55	yellow	12-14	5 1/2
Sundance	70	78	early	.60	yellow	14-16	5 1/2

For Trial Only: early season: Spring Dance(Y) and Spring Calico(Bi).
midseason: Apache (Y), Excellency (Y), Golden Glade (Y), Flavorvee(Y), Merit (Y) and Sweet-Sal (Bi), Sweet Sue (Bi).

For Processing: Jubilee.

Sugar-Enhanced (se) and Shrunken (sh_2) or Supersweet Sweet Corns

The *sugar-enhanced* (se) high sugar sweet corns are hybrids developed with a gene which enhances the sugar content, making them much more flavorful than the standard sweet corn. This group does better than the shrunken (sh_2) types in cold soil, and the early maturing types may be of interest for producers of early corn. Although in our variety trials, we isolate this group by 200 ft. from other types of corn, commercially it is not necessary, except when growing varieties of different kernel color. Then isolating white corn from yellow pollen will be beneficial. The sugar-enhanced types can be handled exactly the same as regular corn. While proper post-harvest handling and storage is critical in maintaining the quality and freshness of corn after picking, the initially higher sugar content may provide some additional flexibility in the length of time between "picking and eating."

The following main season sugar-enhanced types have performed well in annual variety trials:

Yellow: Incredible, Seneca Sentry, Tender Treat, Bodacious, Miracle. **For Trial**: Flavor King, Sugar Ace, Tuxedo, Gold Nuggets.
Bi-color: Calico Belle, Star Struck. **For Trial**: Medley
White: Snow Queen, Silverado, Snow Belle, Silverette.

Shrunken (sh_2) high-sugar supersweet sweet corns have also received much attention. These types tend to have 2-3 times the sucrose content and twice the sugar content of normal sweet corn, and retain their sugar content longer both in the field and after harvest. The rapid proliferation of new commercially available types has resulted in the improved performance (yield, quality and taste) from the older supersweets. However, the rapidly changing varietal picture also has created confusion as to which varieties are most suitable for production in the Midwest.

The following sh_2 types have performed well in our annual variety trials:

Yellow: Landmark, Pinnacle, Sweetie 82, Illini Gold, Ultimate, Sweet Belle, Zenith, Sweet Time, Main Time.
For Trial: Jubilee, Flagship, Challenger.
Bi-color: Sweeter Bi Far, Summer Sweet 8502, Viceroy, Phenomenal (late), Candy Store, Honey N Pearl, Ivory N Gold.
For Trial: Crisp'N Sweet 711 or 730, Dazzle.
White: How Sweet It Is, Summer Sweet 8601.
For Trial: Pegasus, Silver XtraSweet.

The management of shrunkens differs from that of regular and sugar-enhanced sweet corn. Their seeds are smaller and lighter, requiring a much shallower planting depth and adequate soil moisture nearer the soil surface for

good seedling emergence. These types generally germinate very poorly in cold wet soils of early spring and are less hardy to environmental stress such as hot, dry, or windy conditions than the other types of sweet corn. Seed should be planted only when soil temperatures reach approximately 60°F. Sow at heavier rates when conditions are unfavorable. Uneven stands and nonuniform emergence are relatively common. Improved varieties or seed treatment such as coating may overcome this problem. These types are most suitable for later planting dates.The **shrunkens require isolation** from other types of corn (regular, sugar-enhanced, field, Indian and popcorn). Isolate the supersweets by at least 300 ft. from other types of corn. With good stand establishment and favorable growing conditions, very high yields can be obtained.

SPACING AND SEEDING

Rows: 36 to 40 in. apart. Plant early varieties 8 to 10 in. apart in the row, late varieties 9 to 12 in. apart in the row.
Seed: 10 to 15 lb. per acre.

FERTILIZING

Broadcast and plow down 120:0:120 (lb. per acre) $N:P_2O_5:K_2O$.
Band at planting 12:48:0 (lb. per acre) $N:P_2O_5:K_2O$.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Seed rot and damping off	Captan 50W at 1 tsp. per lb. of seed.	Most seed companies deliver pre-treated seed.
Rust	Plant rust resistant hybrids.	Comet, Jubilee, Incredible, Sweetie 82, and many others.
	Apply Bravo 720 at 0.75 to 2 pt. per acre. 14 day PHI. **Do not apply to sweet corn to be processed.** OR mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or Penncozeb DF at 2 to 3 lb. per acre. 7 day PHI.	Apply when severe disease outbreak occurs early in the season. Repeat at 7 day intervals, beginning before tassel emergence and ear formation. Do not apply Bravo less than 14 days before harvest. Do not feed treated forage to livestock.
Smut	Use tolerant hybrids such as Apache, Bellringer, Commanche, Comet, Gold Cup and Merit.	
Stewart's wilt	Plant wilt resistant hybrids.	Apache, Comet, Comanche, Gold Cup, Incredible, Sweet Sue, Seneca Sentry, Miracle, How Sweet It Is.
	Use an insecticide to control flea beetles.	Especially on more susceptible hybrids following a mild winter.
"Helminthosporium" leaf blights, and anthracnose	Plant resistant varieties. Follow a 2-3 year plan.	
	Apply Bravo 720 at 0.75 to 2 pt. per acre. 14 day PHI. **Do not apply to sweet corn to be processed.** OR mancozeb (Dithane DF or Manzate 200) at 1.5 lb. per acre. 7 day PHI.	Begin applying fungicides at the first sign of disease. Apply at 7 day intervals, or as needed to maintain control.
Maize dwarf mosaic, chlorotic dwarf, and wheat streak mosaic	Plant resistant or tolerant varieties. Control Johnsongrass and volunteer wheat.	Esteem

HERBICIDES*	TREATMENT**	COMMENTS
PREEMERGENCE		
Aatrex or others 4L, 80W, Nine-0	1 qt. on light-colored soils, 1 to 2 qt. on darker soils, of 4L, 1.25 to 1.5 lb. per acre of 80W or 1.1 to 2.2 lb. per acre of Nine-0.	Apply at planting time or before corn emerges. Caution: Atrazine remains in the soil and may carryover and injure susceptible crops sown in the fall or following spring - tomatoes, cucumbers, melons, etc. - consult label for specific rotational crops suggested by manufacturer. Not effective on muck soils.
Bladex 4L	2 qt. on light-colored soil 4 qt. on darker colored soil.	Apply immediately after planting. Supersweet (sh_2) corn may be sensitive to Bladex injury.
Dual 8E	2 pt. on light-colored soils, 3 pt. on darker colored soils.	Apply at planting time or before corn emerges. May be mixed with atrazine or Bladex. Use low rates of each herbicide in combinations.
Lasso 4E	2 qt. on light-colored soils, 4 qt. on dark colored soils.	Apply at planting time or before corn emerges. May be mixed with atrazine or Bladex. Use low rates of each herbicide in combinations.
Sutan+ 6.7E	2.5 to 3.5 qt. per acre.	Incorporate to a depth of 3 in. immediately after application. Suppresses nutsedge.
Eradicane Extra 6.7E	4 to 8 pt. per acre.	Will suppress wild proso millet. Must be incorporated. Contains an extender that may lengthen the period of control.
POSTEMERGENCE		
Aatrex, other (Atrazine)	1 to 1.5 pt. 4L per acre or 0.6 to 0.9 lb. of 80W or 0.55 to 0.83 lb. of Nine-0 plus 1 qt. COC per acre.	Apply before weeds are 1.5 in. tall. Check all label precautions and replant restrictions.
2, 4-D (4 lb./gal.)	0.5 to 0.75 pt. amine per acre. OR	Apply after weeds are up. Most effective when weeds are small. Apply with straight boom sprayer if corn is small; do not apply when corn is 12 in. or taller. Avoid drift onto other vegetable crops.
Basagran 4S	0.75 to 1 qt. per acre on small emerged weeds. Repeat application at 7-10 days for yellow nutsedge if necessary.	Do not apply to corn that has been subjected to stress because injury may result.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
STALE SEEDBED		
Roundup (3 lb./gal.)	1 qt. per acre on small emerged weeds; 2 to 5 qt. per acre on perennial weeds. See label for specific weeds.	Apply in 20 to 60 gal. water per acre on emerged weeds before the crop emerges. Does not provide residual control. Can be tankmixed with Lasso plus Aatrex in minimum tillage (see label).

* For specific weeds controlled by each herbicide, check table on page 23.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Seed corn maggot, seed corn beetle, wireworms	Plant seed that has been treated with an insecticide prior to planting. Use either diazinon or a combination of diazinon and lindane. Follow label directions.	Although most sweet corn seed has been treated with a fungicide, it is seldom treated with an insecticide to prevent seed and seedling damage.
Corn rootworms	Apply one of the following at planting if planting corn following corn (see below):	Apply any of these in a 7 in. band over the row and behind the planter shoe in front of the press wheel. Refer to Purdue Publica-tion E-49 for table on rootworm insecticide performance.
	Counter 15G, Furadan 15G, Lorsban 15G at 8 oz. per 1000 linear feet of row.	
	OR	
	Thimet 20G at 6 oz. per 1000 linear feet of row.	DO NOT place Dyfonate, Lorsban, Mocap or Thimet in the furrow or in direct contact with the seed.
	OR	
	Dyfonate II 10G or Mocap 10G at 12 oz. per 100 linear feet of row.	
	Other corn rootworm control considerations: 1. If a crop other than corn was grown in the field the previous year, then there is little chance of a damaging infestation and no need for an insecticide application. 2. If corn was grown in the field the previous year and few or no rootworm beetles were present, then there is little chance of a damaging infestation. 3. If sweet corn was grown in the field the previous year and a regular spray schedule was followed during silking, then there is little chance of a damaging infestation.	
Cutworms	Lorsban 4E at 2 to 3 pt. per acre.	Most effective when soil is moist. If ground is dry, cloddy, or crusty, shallow incorporation using a rotary hoe or other suitable equipment before or soon after treatment may improve control.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Cutworms (cont.)	Asana XL at 5.8 to 9.6 fl. oz. per acre. OR	1 day PHI.
	Ambush 2EC at 6.4 to 12.8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre. OR	1 day PHI.
	Pounce 3.2EC at 4 to 8 oz. or 25WP at 6.4 to 12.8 oz. per acre.	1 day PHI.
Corn earworms	Apply one of the following when moths are present:	Begin sprays when ears begin to silk and when pheromone traps show need. Stop sprays when more than 90% of silks are brown.
	Ambush 2EC at 6.4 to 12.8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre. OR	Apply every 3-5 days or as needed by air or ground. Do not apply more than 1.2 lb. AI per acre per season. 1 day PHI.
	Pounce 3.2EC at 4 to 8 oz. or 25WP at 6.4 to 12.8 oz. per acre. OR	Apply every 3-5 days or as needed. Do not apply more than 1.2 lb. AI per acre per season. 1 day PHI.
	Lannate 90SP at 0.3 to 0.5 lb. or 1.8L at 1.3 to 2 pt. per acre. OR	0 day PHI for ears, 3 days for forage.
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Repeat as needed. Do not exceed 0.5 lb. AI per season. 1 day PHI.
Corn earworms and European corn borer	Ambush 2EC at 6.4 to 12.8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre. OR	Apply every 3-5 days or as needed by air or ground. Do not apply more than 1.2 lb. AI per acre per season. May be mixed with Lannate as per label limitations and precautions. 1 day PHI.
	Pounce 3.2EC at 4 to 8 oz. or 25WP at 6.4 to 12.8 oz. per acre. OR	
	Lannate 90 SP at 0.25 to 0.5 lb. or 1.8 L at 1.3 to 2 pt. per acre. OR	0 day PHI for ears, 3 days for forage.
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Repeat as needed. Do not exceed 0.5 lb. AI per season. 1 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
European corn borer	Penncap-M at 2 to 4 pt. per acre. OR Ambush or Pounce at same rates, restrictions and precautions as for earworm. OR	Not very effective for corn earworm control. 3 day PHI.
	Furadan 4F at 1 pt. per acre.	*MACHINE HARVEST ONLY!* For control of second generation borers. Do not make more than 4 applications per season. Do not graze or harvest stalks within 21 days of last application; 7 days for ears. Do not enter field within 14 days of application without wearing proper protective clothing.

MONITORING EUROPEAN CORN BORER AND CORN EARWORM

One of the keys to successfully managing corn borers and corn earworms on sweet corn is to to be able to determine when the insects are active. European corn borers can be monitored effectively with blacklight traps and field observations and corn earworms can be monitored with pheromone traps. When moths are being caught in the traps it means that egg laying is taking place. Corn borer eggs are laid on the leaves, usually on the underside, in the region of the ear. The larvae will feed on the leaves and later may migrate to the ear, if one is present. Corn earworm moths lay their eggs directly on green silks. The young larvae that hatch out of those eggs will follow the silks down into the tip of the ear. Because the egg laying behavior of the two insects differ, the strategies for their control also differ. Corn borers can be controlled by spraying during the late whorl and tasselling stages as well as during the silking stage. The migrating larvae may contact a lethal dose of insecticide while moving to the ear zone. Corn earworms must be controlled by directing the sprays at the silks so that when the eggs hatch the young larvae will immediately contact the insecticide.

For corn borers, treat during the late whorl stage if 15% or more of the plants show larval feeding. The presence of large numbers of moths in the light trap is also justification for insecticidal treatment. One application during the late whorl stage followed by additional treatments every 5 days until just prior to harvest will usually provide adequate control. For corn earworms, treatment is justified if fresh green silks are present *and* moths are being caught in pheromone traps. In general, the higher the moths catches, the shorter the interval between sprays. If fewers than about 5 moths are being caught per night, a spray interval of 5 days should be adequate. As moth catches approach the level of 50-100 per night, a spray interval of 2-3 days would be more appropriate. The exact determination of the spray interval depends on many factors, including how much damage you can tolerate, the value of the crop, and the cost and effectiveness of the insecticide. Stop treating for corn earworms when 90% of the silks are brown.

Obviously, growers should not treat separately for these two pests. Some of the insecticides we recommend are effective against both species. Choose the insecticides that are more effective against the particular pest that is more prevalent at the time. If both pests are present, choose an insecticide that will adequately control both of them.

Sweet Potato

Varieties

Beauregard:	Early, increasingly popular.
Centennial:	Soft-fleshed type, orange skin.
Julian:	Deep orange, good quality (same as Centennial).
Nugget:	Firm-fleshed type, orange skin, orange flesh, good quality, excellent keeper.

Plant Production

Select seed stock from high-yielding hills that are smooth, well-shaped and free from diseases (scurf, internal cork, wilt, black rot) and insect injury. Where internal cork is present, obtain seed stock from suppliers who have cork-free stock. Store the seed stock in new crates to avoid disease contamination. Seed potatoes should be at least 1.5 in. in diameter. One bushel of small- to medium-sized roots should produce 2,000 to 2,500 plants (slips) from three pullings.

Treating seed before planting with Mertect 340-F will protect roots from infection by certain disease-causing organisms. Bed the seed stock in new, clean sand taken from upland banks or pits. Allow 10 to 12 sq. ft. of bed area per bushel of seed. Maintain plant bed temperature at 75 to 85°F.

Transplanting and Spacing

Transplanting machines are available for mechanically planting sweet potato slips. Common spacing is 1 ft. apart in the row, with rows 3 to 4 ft. apart, depending upon the cultivating and harvesting equipment used. 14,520 slips per acre are required at the 1 ft. by 3 ft. spacing while 10,890 are needed at the 1 ft. by 4 ft. spacing. Transplant only strong, stocky slips. Yields can be increased up to 100 bu. per acre by using strong transplants.

Fertilizing

Broadcast and plow down 40:60:180 (lb. per acre) $N:P_2O_5:K_2O$. Set plants with a starter solution of 3 lb. soluble, high phosphate fertilizer in 50 gal. water. Be sure each plant receives at least 0.25 to 0.5 pt. of this solution.

Harvesting

Remove vines by cutting with a rotary mower. Dig only those potatoes that can be picked up immediately and not left out overnight. Temperatures below 50°F can chill potatoes and cause internal breakdown in storage. Potatoes will sunburn if left in direct sunlight over one hour. Field grading is important.

Prevent skinning and breaking. Use cotton gloves when placing potatoes in crates. Place well shaped No. 1's with No. 2's, and cuts with culls.

Storing

When the storage house is filled, raise the temperature to 85°F. Keep it at this temperature 6-8 days with 85 to 90% humidity for proper curing. After curing, the temperature may be dropped gradually to 55°F. Hold this temperature until potatoes are marketed or used for producing slips.

DISEASES Controlled	Treatment	Comments
Black rot, foot rot, Fusarium wilt, and scurf	Plant disease free seed and/or resistant varieties. Follow 3-4 year crop rotations. Dip roots or sprouts in Mertect 340F (8 fl. oz. per 7.5 gal. water) or Thiram 75W (1 lb. per 7.5 gal. water).	Dip roots and sprouts in solution for 2 minutes and plant immediately.
Storage rots	Fumigate storage boxes. Use Botran as a post-harvest dip.	Cure and store only healthy, blemish-free tubers.

Herbicide*	Treatment**	Comments
PREEMERGENCE		
Dacthal 75WP	8 lb. on light-colored soils (less than 2% organic matter), 14 lb. on dark colored soils in at least 50 gal. water per acre.	Apply immediately after transplanting, using 50-mesh or larger screens. This material gives best results on light, sandy soils.
POSTEMERGENCE		
Fusilade 1E	1.25 to 1.5 pt. per acre plus 1 pt. nonionic surfactant per acre.	Apply to actively growing grass. 55 day PHI.
STALE SEEDBED		
Roundup (3 lb./gal.)	2 to 3 qt. per acre.	Apply to emerged weeds before planting in spring or after harvest in fall. Check label for specific weeds controlled and for recommended rate.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS Controlled	Treatment	Comments
Wireworms, flea beetle larvae	Lorsban 15G at 13.5 lb. per acre.	Evenly distribute granules over treated area, and after application incorporate to depth of 4 to 6 in. by rotary hoe or disc cultivator. 125 day PHI.

A. Processing Varieties

Variety	Season	Crack Resistance	Fruit per Pound	Firmness	Disease Resistance[1]	Comments[2]
O 7983	Early		7-8	Good	VF	j, O.P
O 7814	2nd Early		7-8	Good	VF	j, O.P.
O 8245	Main		6-7	Good	VF	j, O.P., less prone to anthracnose
Peto 696	Main		6-7	Good	VFASt	j, F1 hybrid
PU 861	Main		7-8	Fair	VF	j, F1 hybrid

B. Trial Varieties

O 8550	2nd Early		7-8	Good	VF	j, O.P.
Peto 1596	2nd Early		7-8	Good	VFN	j, F1 hybrid
OX1	Early		7-8	Good	VF	j, F1 hybrid
OX4	Early		7-8	Good	VF	j, F1 hybrid
SO12	2nd Early		7-8	Good	VF	j, F1 hybrid

Disease Resistance: V = Verticillum wilt (race 1); F = Fusarium wilt (race 1); St = Gray Leaf Spot; A = Alternaria Stem Canker; N = Root Knot Nematode

Comments: j = jointless pedicel; OP = open pollinated(inbred line)

C. Fresh Market Varieties

Variety	Season	Crack Resistance	Fruit per Pound	Color Index	Firmness	Disease Resistance[1]	Vine Type[2]	Calyx Removal[3]
Bingo*	Main[5]	Good	2.0	Good	Good	VF	D	-
Celebrity	Mid-Early	Fair	2.5-3		Fair		D	
Duke*	Main	Good	2.5-3	Good	Good	VF	D	-
Jet Star*	Early	Fair	2.5	Good	Fair	VF	I	+
Mountain Pride*	Main	Good	2.5	Good	Good	VF	D	+
MT Delight	Mid	Good	2-2.5		V. Firm		D	
MT Spring	Main	Exc.	2-2.5		V. Firm		D	
Pik Red	Early[5]	Fair	2-2.25	Good	Good	VF	D	+
Pik Rite	Early[4]	Fair	2.25-3		Firm		D	
Sunny*	Main[5]	Fair	2.5	Good	Fair	VF	D	+
Sunrise	Early	Good	2-2.5		Firm		D	

[1] Disease Resistance: V = Resistant to Verticillium wilt; F = Resistant to Fusarium wilt.
[2] Vine Type: I = Indeterminate (long vine); D = Determinate (short vine).
[3] Pedicel Type: + = normal jointed pedicel; - = jointless pedicel.
[4] Not recommended for southwestern Indiana.
[5] Not recommended for Iowa.
* F_1 hybrid.

For Trial Only: Enterprise, Market Pride, Olympic, Sunbeam, Summerset, Ultrasweet, Merced.

DIRECT SEEDING

Tomatoes for processing may be seeded to stand. Consult your local factory fieldman regarding equipment for direct seeding in your area. Always use a high phosphate starter fertilizer between the seed or under the seed.

TRANSPLANTING

6- to 8-week old transplants, dug from disease-free fields and rushed to growers for immediate field planting, give maximum assurance of good stands and high yields. Bad weather, however, may seriously delay transplanting, damage stands and lower yields. In an emergency, plants may be kept in reasonably good condition stored at 50 to 55 F, provided the combined handling, transit, and storage time does not exceed 10 days.

ETHEPHON APPLICATION (for processing only)

Applications of ethephon results in acceleration and concentration of fruit ripening, thus facilitating once-over machine harvesting and the opportunity to schedule multiple hand harvests.

For Machine Harvest: 3.25 pt. Ethrel or Cepha in 5 to 70 gal. of water per acre applied as spray over entire plant when 10 to 30 percent of fruits are ripe. Harvest 15 to 21 days after treatment for optimum ripe fruit accumulation.

For Hand Harvest: 3.25 pt. Ethrel or Cepha in 5 to 70 gal. of water per acre applied at mature green fruit stage increases first harvest yields. Application after the first or second harvests will increase ripe fruit yields in subsequent harvest and allow earlier and more complete harvest of fruit load.

SPACING

Direct Seeding: Rows 4.5 to 5.5 ft. apart. Precision seeding of 3 to 5 seeds in clumps every 9 to 10 in. in the row is recommended. If soil has a tendency to crust, band an anti-crustant in the seed furrow for dependable emergence. For increased fruit accumulation, seed double rows 18 in. apart with 6 ft. from center to center of double rows. Drop seed clumps at 12 to 18 in. in the row. Cover seed with anti-crustant for optimum germination.

Transplanting: Rows 4 to 5.5 ft. apart (use wider spacings for machine harvest). Plants 16 to 18 in. apart in the row. Yields increase significantly with plant populations up to at least 8,000 plants per acre.

FERTILIZING

Broadcast and plow down 100 lb. P_2O_5 and 240 lb. K_2O per acre.

Nitrogen Application Rates: Broadcast and plow down or disc in the spring:

Stand Establishment Method	Machine Harvest — Sand	Machine Harvest — Silt loam or heavier	Multiple Harvest
	(lb. N/acre)		
Seeding	90-120	60-75	80-120
Transplanting	60-90	50	75-100

Starter Fertilizer: Transplants — use a starter solution of 3 lb. 10-52-17 or equivalent, dissolved in 50 gal. of water (or dilute 10-34-0 liquid 1:100 with water – 1 gal. 10-34-0 + 99 gal. water). Add 0.5 pt. of solution per plant.

Seeded (placed on the seed) — Spray directly on the seed a solution of 2-6-0 at 1 pt. per 100 ft. of row (use 1/2 the rate on sandy soils). A 2-6-0 solution is equivalent to a 1:5 dilution of 10-34-0 liquid fertilizer with water.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Damping off (Pythium) **field use only**	Ridomil 2E at 2 to 4 pt. per acre as a preplant broadcast spray in 50 gal. water before or at time of seeding.	For field seeded crops. Calibrate equipment accordingly for band applications over the row. Seeds should be treated with captan or thiram (1/2 tsp. per lb. seed) before planting. Most seed companies deliver pre-treated seed. Check the seed package to determine the kind of seed treatment used. If no treatment was applied, then use a chemical seed treatment.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Anthracnose	3-4 year crop rotation	Rotate out of fields with a history of anthracnose.
	Bravo 720 at 2 to 3 pt. per acre. OR Bravo 90DF at 1.5 to 2.5 lb. per acre. OR	Use 7-10 day spray intervals. 0 day PHI.
	mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or Penncozeb DF at 2 to 3 lb. per acre. 5 day PHI.	Manex II is an alternative mancozeb fungicide for those who prefer the flowable formulation.
Bacterial canker	Obtain disease-free seed and/or transplants from a reliable source. Copper sprays are generally ineffective in controlling canker.	Fields with a canker history should be planted to crops other than tomatoes, potatoes, peppers and eggplant for at least 3 years. Sanitize machinery, seedling and plant production materials (wooden flats, plastic trays, greenhouse benches and wooden stakes) with a 10% chlorine bleach solution. Avoid working in wet canker fields.
Bacterial speck, bacterial spot	**For seed bed treatment:**	
	Agri-Strep at 1 lb. per 100 gal. water (200 ppm).	Apply to seedlings when first true leaves appear and repeat at 5 day intervals. Agri-Strep is registered for use on tomato seedlings only before they are transplanted.
	For field treatment: Apply a copper spray beginning when disease first appears. Use a 7-10 day spray interval. 0 day harvest restriction: Tribasic copper sulfate 53W at 2 to 4 lb. per acre. OR Kocide 101 or Kocide DF or Kocide 606 applied at label rates. OR Champion WP at 2 to 3 lb. per acre	Bacterial speck is more likely to spread in cool wet weather; bacterial spot is favored by warm wet weather.
Blossom end rot	Choose a processing tomato cultivar that is less prone to blossom end rot.	A physiological disorder related to calcium deficiency. Rot is promoted by variances in available water and excessive vine growth rates.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Buckeye rot	Ridomil 2E at 4 pt. per acre.	Apply as a soil surface application under vines. 28 day PHI
Early blight, Septoria leaf blight	Apply one of the following fungicides at the first sign of disease:	Apply fungicides regularly on a 7-10 day spray interval. Rotate out of fields with a history of early blight.
	Bravo 720 at 2 pt. per acre.	0 day PHI.
	OR	
	Bravo 90DF at 1.5 to 2.5 lb. per acre	0 day PHI.
	OR	
	mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or Penncozeb DF at 2 to 3 lb. per acre. 5 day PHI.	Manex II is an alternative mancozeb fungicide for those who prefer a flowable formulation.
Fusarium and Verticillium wilts	Use wilt resistant "VF" cultivars and avoid fields with a wilt history.	
Late blight	Apply one of the following fungicides at regular intervals:	Apply Ridomil MZ-58 or Ridomil/Bravo 81W at 2 lb. per acre at first sign of disease.
	Ridomil MZ-58 at 1.5 to 2 lb. per acre.	14 day spray interval, 5 day PHI.
	OR	
	Ridomil/Bravo 81W at 1.5 to 2 lb. per acre.	14 day spray interval, 0 day PHI.
	OR	
	Bravo 720 at 2 pt. per acre.	7 day spray interval, 0 day PHI.
	OR	
	Bravo 90 DF at 1.5 to 2.5 lb. per acre.	7 day spray interval, 0 day PHI.
	OR	
	mancozeb fungicides: Dithane DF or Dithane M-45, or Manzate 200 DF, or Penncozeb DF at 2 to 3 lb. per acre. 5 day PHI.	Manex II is an alternative mancozeb fungicide for those who prefer a flowable formulation.
Sclerotinia stem rot	Use disease-free transplants.	Avoid fields with a history of stem rot.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Dacthal 75WP	8 lb. on light-colored soils (less than 2% organic matter), 14 lb. on darker-colored soils in at least 50 gal. water per acre.	Apply 4-6 weeks after transplanting or on direct seeded plants at 4-6 inches in height. Use 50-mesh or larger screens. Not effective on muck or other high organic soils.
Devrinol 50DF	2 lb. per acre on light-colored soils (less than 2% organic matter), 4 lb. on other soils.	Incorporate 1 to 2 in. deep before seeding or transplanting. After harvest or prior to planting succeeding crops, a deep moldboard or disc plowing operation must be carried out. Do not seed alfalfa, small grains, sorghum, corn or lettuce for 12 months after using Devrinol.
Lexone or Sencor	0.5 to 1 pt. of 4L or 4F or 0.33 to 0.66 lb. of 75DF per acre. TRANSPLANTS ONLY.	Apply as a broadcast spray immediately before transplanting and incorporate to a depth of 3 to 4 in. This application may be made alone or in a tank-mix combination with Treflan EC adjusted for soil type.
Tillam 6EC	2.7 qt. per acre on light-colored soils, 4 qt. per acre on darker soils.	**Transplants:** Apply and incorporate 2 to 3 in. into soil before transplanting. **Seeded:** Apply as a directed spray to clean cultivated soil and incorporate or irrigate in after tomatoes are well-established.
Treflan 4E	0.6 pt. on light-colored soils (less than 2% organic matter), 1.5 pt. on darker-colored soils in 25 gal. or more water per acre. FOR TRANSPLANTS ONLY.	Apply before transplanting and incorporate immediately into soil by double discing or with other equipment to give thorough mixing to about 4 in. deep. May cause some early stunting. Follow all label directions. To prevent stunting, dip roots in carbon slurry (2 lb. per gal.) before transplanting or put 2 oz. of carbon per gal. in transplant water.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
POSTEMERGENCE (cont.)		
Poast 1.5E	1.0 to 1.5 pt. per acre plus 1 pt. nonionic surfactant per acre. Transplants or seeded.	Apply to actively growing grass. Maximum of 4.5 pt. per acre per season. 20 day PHI.
Lexone or Sencor	0.5 to 0.75 pt. of 4L or 4F, or 0.33 to 0.67 lb. of 75DF per acre.	Use as a broadcast spray in single or multiple applications with a minimum of 14 days between sprays. Do not treat seeded tomatoes until plants have reached 5 to 6 leaf stage or transplants have recovered from shock. Do not apply within 3 days of cool, wet or cloudy weather or crop injury may occur. Do not apply more than 2 lb. Sencor per crop season. 7 day PHI.
STALE SEEDBED		
Gramoxone Extra 2.5E	2 to 3 pt. plus 1 pt. nonionic surfactant per acre.	When direct seeding, if resistant broadleaved weeds emerge before tomatoes, Gramoxone Extra may be applied just before tomatoes emerge. RUP.
Roundup (3 lb./gal.)	2 to 3 qt. per acre. Direct seeded only.	Seeded tomatoes only. Apply to emerged weeds before planting crop. Wait 3 days before planting.

* For specific weeds controlled by each herbicide, check table on page 23.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Flea beetles	Use one of the following as needed:	Flea beetles often infest tomato seedlings and transplants. Plants should be examined frequently to determine the need for insecticide applications.
	Sevin 50WP at 2 lb., or 80SP at 1.25 lb. per acre.	0 day PHI.
	OR	
	Rotenone 1D at 25 to 30 lb. per acre.	
	OR	
	Guthion 2S at 2 to 3 pt., or 50WP at 1 to 1.5 lb. per acre.	Do not make more than 4 applications per season. Allow 7 days between applications. 0 day PHI at low rates. 14 day PHI at rates above 3 pt. or 1.5 lb.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Colorado potato beetle and larvae	Crop Rotation	Planting fields as far as possible away from last year's tomatoes will reduce potato beetle damage.
	Cultural Control	The use of straw mulch reduces potato beetle damage.
	Scouting	Regular (weekly) scouting of fields will allow you to determine the necessity for, and improve the timing of, insecticide treatments.
	Apply one of the following as needed:	Colorado potato beetles are becoming resistant to some insecticides.
	Asana XL at 5.8 to 9.6 fl.oz. per acre.	Do not exceed 0.35 lb. AI per acre per season. 1 day PHI.
	OR	
	Sevin 50WP at 2 lb. or 80SP at 1.25 lb. per acre.	0 day PHI.
	OR	
	Monitor 4EC at 2 pt. per acre.	7 day PHI.
	OR	
	Guthion 50 WP at 0.75 lb. or 2S at 1.5 pt. per acre.	0 day PHI.
	OR	
	Thiodan 50WP at 1 to 2 lb or 3EC at 0.67 to 1.33 qt per acre.	2 day PHI. Do not exceed 6 applications, or 3 lb. AI per acre per season.
	OR	
	M-One at 1.5 to 2.5 qt. per acre, or Trident II at 1.5 to 3.0 qt. per acre, or M-Trak at 1.5 to 4.0 qt. per acre, or Novodor at 1.0 to 4.0 qt. per acre.	*Bacillus thuringiensis* based insecticides. Controls only small larvae. Other materials will need to be used to control adults and large larvae. 0 day PHI.
Cutworms	Monitor 4EC at 2 pt. per acre.	Should also control loopers and aphids. 7 day PHI.
	OR	
	Sevin 50WP at 4 lb., 80SP at 2.5 lb. per acre.	0 day PHI.
Hornworms	Use one of the following as needed:	
	Guthion 50WP at 1.5 to 3 lb. or 2S at 3 to 6 pt. per acre.	1.5 lb. rate, 0 day PHI; higher rates, 14 day PHI.
	OR	
	Sevin 50WP at 2 to 4 lb. per acre.	0 day PHI.
	OR	
	Asana XL at 2.9 to 5.8 fl. oz. per acre.	1 day PHI.
	OR	
	Dylox or Proxol 80SP at 1.25 lb. per acre.	21 day PHI.
	OR	
	Bacillus thuringiensis (MVP, Javelin, Dipel, Biobit). Follow label directions.	0 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Fruitworms	Pheromone Traps	Pheromone traps effectively detect Fruitworm moth activity and help improve the timing of insecticide applications.
	Sevin 50WP at 4 lb., or Sevin 80 SP at 2.5 lb. per acre.	0 day PHI.
	OR	
	Lannate 90SP at 0.5 to 1 lb. per acre, or 1.8L at 2 to 4 pt. per acre.	1 day PHI. Will also control aphids.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	1 day PHI.
	OR	
	Thiodan 50WP at 1 to 2 lb or 3EC at 0.67 to 1.33 pt. per acre.	2 day PHI
	OR	
	Bacillus thuringiensis (MVP, Javelin, Dipel, Thuricide, Biobit). Follow label directions.	0 day PHI.
Aphids	Conserve natural enemies.	Limiting the use of insecticides other than *Bacillus thuringiensis* products will conserve predators and parasites that help keep aphid populations under control.
	Use one of the following as needed:	
	Lannate 1.8L at 2 to 4 pt per acre.	1 day PHI.
	OR	
	Cygon 2.67EC or Dimethoate 400 at 0.5 to 1 pt. per acre.	7 day PHI.
	OR	
	Mevinphos 400 at 0.25 to 0.5 pt. per acre.	*HIGHLY POISONOUS!* Do not enter treated areas without protective clothing until sprays have dried. 1 day PHI.
Russet mite	Wettable sulfur (84 to 95%) at 10 lb. per acre.	Sulfur dusts are also effective.

Fruit flies, vinegar flies (*Drosophila* spp.)	Use all of these procedures to prevent contamination of tomato products by fruit fly eggs and maggots: (1) Provide *unplanted* driveways through field to prevent fruit damage. (2) Starting 2 weeks before harvest, place bait fruits in fields in late afternoon, and examine next morning. (3) If half of the baits show eggs, spray fields immediately and at 4-6 day intervals with one of the following: Diazinon 50WP at 1.5 lb. or AG500 at 1.5 pt. per acre. (4) Dust fruit and hampers as soon as filled with a dust containing 0.1% stabilized pyrethrins plus 1.0% piperonyl butoxide. (5) Move hampers to processing plant as soon as possible.	Harvesting Tips: (1) Avoid crushing fruit with trucks or spray equipment. (2) Pick fruit carefully to avoid bruising. (3) Fill hampers, boxes and trucks in such a way that fruits will not be damaged during transit. (4) Do not allow filled hampers to remain in the field overnight. (5) Process tomatoes the same day they are picked, and as rapidly as possible. (6) Keep hampers and trucks clean. 1 day PHI.

Calibration of Application Equipment

Rate of application, granular and sprays, may vary with materials used. Equipment must be calibrated for each material applied to obtain accurate delivery. Here are suggested steps to calibrating three types of applicators.

BOOM SPRAYER

1. Clean sprayer, and replace all worn or defective parts; fill tank with water.
2. Adjust spray pressure and speed of tractor for nozzle size and output using manufacturer's directions.
3. Spray 1/4 acre (10,890 sq. ft.). Distance of travel will vary with boom width.
   For example, a 22 ft. boom must travel 495 ft. to cover 1/4 acre:

$$\frac{\text{1/4 acre (10,890 sq. ft.)}}{\text{Boom width (22 ft.)}} = \text{distance of travel (495 ft.)}$$

4. Measure amount of water needed to refill the tank. This amount was applied to the 1/4 acre; thus, four times this amount is the gallonage per acre.
5. Adjustment in gallonage may be made either by varying tractor speed or by changing nozzle size. Recalibrate after making an adjustment.
6. Calculate acres covered by tank of spray solution, and add required amount of pesticide for total area sprayed.

BAND SPRAYER

1. Clean sprayer, and replace all worn or defective parts; fill tank with water.
2. Adjust spray pressure and speed of tractor for nozzle size and output using manufacturer's directions.
3. Spray 1/4 acre (10,890 sq. ft.). Distance traveled will vary with number of rows on the planter and row width.
   For example, band spraying over 4 rows spaced 40 inches requires 817 ft. to cover 1/4 acre:

$$\frac{\text{1/4 acre (10,890 sq. ft.)}}{\text{Rows (4) x row widths (3.33 ft.)}} = \frac{\text{10,890 sq. ft.}}{\text{13.33 ft.}} = \text{distance of travel (817 ft.)}$$

4. Measure amount of water needed to refill the tank. This amount was applied to the 1/4 acre; thus, four times this amount is the gallonage per acre.
5. Adjustment in gallonage may be made either by varying tractor speed or by changing nozzle size. Recalibrate after making an adjustment.
6. Calculate acres covered by tank of spray solution, and add required amount of pesticide for total actual area to be band treated.

GRANULAR BAND APPLICATOR

1. Set applicator dial or dials to give desired delivery rate of granules, suggested for band treatment, according to manufacturer's instructions.
2. Fill hoppers with granules to be used.
3. Travel across field at planting speed for the distance required to cover 1/16 acre (2,722 sq. ft.) per row. Collect granules for each row in a bag, bucket or other container. For example: granular band application for a 40-inch row requires 817 ft. to cover 1/16 acre:

$$\frac{\text{1/16 acre (2,722 sq. ft.)}}{\text{Row width (3.33 ft.)}} = \text{distance to travel (817 ft.)}$$

4. Weigh granules from each row separately, and multiply by 16 to find delivery per acre for each row.
5. Adjust each setting, and recalibrate until the desired delivery rate is obtained.

Illinois Horticulture/Food Crops & Integrated Pest Management Educators

Food Crop Horticulture

Office Locaiton	Educator	Address	Office Phone
DeKalb Extension Center	William Whiteside	155 N. 3rd. St., Suite 200 DeKalb IL 60115	(815) 748-5200
Edwardsville Extension Center	C. Chris Doll	University of Illinois 200 University Park Dr. University Park SIU-E Edwardsville IL 62025-3636	(618) 692-9434
Marion Extension Center	Eddie Billingsley	Dixon Springs Agr. Center Box 256 Simpson IL 62985	(618) 695-3597

Integrated Pest Management

Office Location	Educator	Address	Office Phone
Countryside Extension Center	Fredric Miller, Jr.	6438 Joliet Rd. Countryside IL 60525	(708) 352-0109
Quad Cities Extension Center	Deve Feltes	1414 10th St., Suite 2 Silvis IL 61282	(309) 792-2500
Springfield Extension Center	George Czapar	P.O. Box 8199 Springfield IL 62791	(217) 782-6515
Champaign Extension Center	Suzanne Bissonnette	1401D Regency East Savoy IL 61874	(217) 333-4901
Marion Extension Center	Noel Troxclair, Jr.	901 W. Washington Benton IL 62812	(618) 439-7263
Edwardsville Extension Center	Tom Royer	University of Illinois 200 University Park Dr. University Park SIU-E Edwardsville IL 62025-3636	(618) 692-9434

Educators responsible for vegetable production and integrated pest management will be hired in 1993 for positions at Extension Centers in Macomb and Kankakee, respectively. Consult local Extension Unit leaders for addresses and phone numbers during the 1993 season.